THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL.

VOL. 29. Thursday, March 27, 1924. No. 397.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial, 17s. 6d. per annum.
All Subscriptions are payable in advance.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
BESSEMER HOUSE, 5, DUKE STREET, ADELPHI,
LONDON, W.C.2.

Contents.

	PAGE
New Era in Foundry Research	247
British Cast Iron Research Association	248
Correspondence	248
Patent Specifications	248
Jolt Ramming Moulding Practice	249
Some Experiments on Cast Iron	252
Institute of British Foundrymen	254
A Ridiculous Action	254
Recent Innovations in the Metallurgical Microscopes	255
British Empire Exhibition	258
Contracts Open	258
Should Pig-iron be Bought by Fracture or Analysis?	259
Physical Tests for Cast Iron	262
Company News	263
Trade Talk	264
Gazette	264
Obituary	264
Personal	264
Iron and Steel Markets	266

Forthcoming Events.

MARCH 27.

Institute of British Foundrymen (Newcastle-on-Tyne Branch):—Ordinary meeting at Newcastle-on-Tyne. "Apprenticeship and the Foundry Trades," Paper by T. Makemson.

Institute of British Foundrymen (Falkirk and District Branch):—Ordinary meeting at Falkirk. "Conveyance of Metal and Material in the Foundry," Paper by J. M. Primrose.

APRIL 1.

Institution of Engineers and Shipbuilders in Scotland:—Ordinary meeting at Glasgow. "Monel Metal, Its Origin, Properties, and Uses," Paper by Engineer Rear-Admiral W. J. Anstey, C.B., R.N.

APRIL 2.

Institute of British Foundrymen (Coventry Branch):—Ordinary meeting at Coventry. "The Influence of Composition and Heat Treatment upon the Microstructure and Physical Properties of Cast Iron," Paper by H. Beeny.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institute of British Foundrymen.

PRESIDENT, 1923-24, Oliver Stubbs, M.I.Mech.E., Openshaw, Manchester.

LIST OF SECRETARIES—

General Secretary: W. G. Hollinworth, 38, Victoria Street, London, S.W.1
Lancashire: T. Makemson, 21, Beresford Road, Gorse Hill, Stretford, Manchester.
Birmingham: H. James Roe, 33, Herbert Road, Bearwood, Birmingham.
Sheffield and District: W. A. Macdonald, 62, Bannerdale Road, Sheffield.
Scottish: J. Bell, 60, St. Enoch Square, Glasgow.
London: H. G. Sommerfield, Charterhouse Chambers, Charterhouse Square, London, E.C.1.
Newcastle-on-Tyne: H. A. J. Rang, 2, St. Nicholas Buildings, Newcastle-on-Tyne.
East Midlands: H. Bunting, 17, Marcus Street, Derby.
Coventry: J. M. Meston, 37, Melville Road.
West Riding of Yorkshire Branch: A. Love, 232, Gladstone Street, Bradford.
South Wales and Monmouth Branch: J. J. McClelland, M.I.Mech.E., Druslyn, Whitechurch.

Welsh Engineers' and Founders' Association.

Secretary: E. J. Griffiths, 20, Fisher Street, Swansea.

New Era in Foundry Research.

Lord Weir gave utterance to some plain speaking to the foundry industry at the recent annual meeting of the British Cast Iron Research Association, He pointed out that the Association was being supported by the large firms to a much greater extent than by the small and medium-sized foundries, who were likely to derive most advantages from research work, since many do not even possess a metallurgist or chemist.

During the last few years there have been difficulties on both sides. Founders and blast-furnace owners have experienced an unprecedented trade depression, particularly unfortunate in its effect in destroying the optimism which pervaded British industry during the post-war boom. The Association also has taken time to determine a satisfactory internal organisation. We believe that during the last few weeks it has set its house in order in no uncertain fashion, and is now in a position to undertake the work which the foundry industry needs and, indeed, has a right to expect.

The necessity for conducting research on a co-operative basis has been urged, almost *ad nauseam*, in this column. The men who are competent to carry out investigations are scarce, and in any case few foundries can afford to maintain a proper staff of research men. It is patent, however, there is an immense amount of work to be done. Foundries differ in many ways—in size, in character and quality of product—but all have some common features, particularly the equipment for metal melting and the methods of mould preparation. All British foundries have to make use of particular brands of pig-iron. In practically no field of modern industry is scientific knowledge so small or so little applied as in foundry practice.

As Lord Weir emphasised at the meeting in question, cast iron was now called upon to fulfil specifications and service requirements which would have been deemed impossible even five years ago. Cast iron has too frequently been regarded as a Cinderella among materials, often distrusted by engineers and designers, and replaced by other materials immediately the demands in the direction of strength and ductility increase. It is the function of scientific investigation to enable founders to produce high-quality material consistently with a minimum of scrap and waste.

Some of the Research Associations are conducting necessary and valuable research work of too academic a type. Some work of this kind is required in connection with cast iron, but the large part of foundry ignorance lies in the actual melting process itself. It is in this direction that the Association can be of greatest service to its members, and we hope that the Research Committee will keep prominently in view the necessity for investigations of a practical type, which will be of direct aid to the small and medium-sized foundry.

Another phase of foundry work which also is urgent is a knowledge of how to get the best out of, primarily, local sands, and secondarily British deposits. For the sale of sand there should be but little competition, for this material, like pig-iron, can never be bad—it is only a case of its correct preparation and application. Foundrymen must be placed in a position to test and treat sand. They must be just as familiar with the import of a permeability figure as at present they are with the meaning of a silicon percentage. Much of this knowledge is available, but it requires collecting, co-ordinating and translating into foundrymen's language. This, too, a phase of research work, which can advantageously be included in the new era now announced.

XUM

British Cast Iron Research Association.

Annual Meeting.

The third ordinary general meeting of the British Cast Iron Research Association was held at the Institution of Mechanical Engineers on March 20, the President, Lord Weir of Eastwood, in the chair.

In moving the adoption of the report and balance-sheet, Lord Weir pointed out that the history of the Association to date had coincided with a period of grave trade depression, from which the foundry industry had not escaped. This state of affairs had handicapped the Association considerably in preventing the accession of new members, but there were now signs of distinct trade improvement, and more members might be expected to join. The membership was still far from representative of the industry, especially among small and medium sized foundries, which would derive greatest benefit from research. There was in the industry complete vocal agreement as to the necessity for research, but this was not accompanied by the necessary financial support. He desired to appeal in the strongest possible terms to every foundry in the country to join the Association, help in its conduct, and share in its advantages.

In spite of its teething troubles, the Association had been of undoubted value to its members. He desired to emphasise the democratic and nation-wide basis on which the Council was elected—from 16 foundry areas into which the country was divided.

Dealing with changes in the Association during the year, they had to deplore the loss of Dr. J. E. Stead as vice-president. As one of the great metallurgists of the world, the loss of his wise counsel and unique technical ability was a severe blow to the Association. Dr. P. Longmuir, Director of Research, had been compelled by continued ill-health to vacate his office, and Mr. T. Vickers, the secretary, had resigned. They welcomed as Director of the Association Mr. J. G. Pearce, who had had considerable experience in industrial research work, and had seen a great deal of the internal management and organisation of research associations. The Council confidently anticipated under his guidance a steady expansion of the work and prestige of the Association. The valuable services and long experience of Mr. J. E. Fletcher would be available to members through his appointment as Consultant to the Association.

With regard to research work, employers were having to bear burdens of reducing costs in spite of high wages and taxation, and only through research could come that improvement in material, process and method which resulted in diminished working costs. Furthermore, cast iron was now being asked to do work in power machinery which cast iron as known in the past was incapable of performing. It had to meet conditions of stress, temperature, erosion and design which called for a degree of exact metallurgical and foundry knowledge which no one possessed even five years ago.

The Research Committee of the Council was developing a balanced research programme, including the three principal sections; fundamental research on cast iron and its constituents and their relations to one another; the development of irons for special purposes, such as resistance to corrosion, erosion, heat, abrasion, etc.; and investigations on cupola and moulding practice and auxiliary materials, sands, fuels, slags, fluxes and refractories.

Mr. A. L. Hetherington, of the Department of Scientific and Industrial Research, who apologised for the absence of Sir Frank Heath, said that the progress of the Association had been watched by the Department with sympathetic interest, and any assistance they could render was at the disposal of the Association.

The department felt that in the new director the Association had an officer who possessed just the kind of experience required to make the Association successful in future, and considered that the Council had every reason for confidence.

The reports and accounts were adopted, and Professor H. C. H. Carpenter, F.R.S., of the Imperial College; Professor C. H. Desch, F.R.S., of Sheffield; Professor C. A. Edwards, of Swansea; and Professor F. C. Thompson, of Manchester, were elected honorary members of the Association.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

John Surtees' Memorial Medal.

To the Editor of The Foundry Trade Journal.

Sir,—I have pleasure in enclosing photograph showing on the left Robert McNab, winner of the "John Surtees Memorial Medal" for apprentices, on the right Vincent McGowan, who gained third place in the examination.

The lads are joint subscribers to The Foundry Trade Journal, and are both employed in the foundry department of Messrs. Fullerton, Hodgart & Barclay, Limited, Vulcan Works, Paisley.

They have been attending a class for apprentices and journeymen which is held in the works laboratory by the works chemist, Mr. J. Y. Anderson.

I hope this photograph may help to encourage other apprentices to take an interest in the technical side of their trade. It seems to me that education of this kind enables a boy to appreciate the opportunities which lie before him in the foundry trade, and to realise that the motto of the Institute of British Foundrymen, "Science hand in hand with labour," is not a mere catchword.—Yours, etc.,

H. M. Hodgart.

Vulcan Engine Works, Paisley.
March 17, 1924.

Patent Specifications.

Particulars of Complete Specifications Accepted, furnished by Mr. Eric Potter, Patent Agent, of 27, Chancery Lane, London, W.C.2. Printed copies of the specifications in the following list are now on sale.

Beardsley, E. O., and Piper, W. F. Foundry moulding machines. No. 212,349.

Meehan, A. F., 1061, Carter Street, Chattanooga, Tennessee, U.S.A. September 26, 1922. No. 25,973. (Class 72.)

Purifying and Refining.—To convert white iron into grey iron, a carbon precipitating silicide other than a carbon silicide, substantially free from iron, such as calcium silicide, is added to molten white iron either in a ladle or in a bath within the furnace.

Jolt-Ramming Moulding Practice.*

By A. L. Key, M.I.Brit.F.

The purpose of presenting this Paper is primarily to present the author's practice with jolt-ramming machines. It is not intended in any way to assume that the practical application is intended to represent the last word on jolt-ramming, in so far that this system is still full of possibilities. For progress for the foundryman there is great scope, provided that he is prepared to undertake a fair amount of extra work, for personal attention is *sine quâ non* until each individual job is established.

Any scheme for increasing production should be considered, first from the aspect of its effect upon the workman, for if speeding up of production has to be done, it should not be considered if it is going to inflict unnatural conditions on those who have to provide the physical power. From this point of view alone the jolt-rammer highly commends itself, inasmuch that the saving in direct energy is remarkable. The increase in production and quality is governed by the general lay-out of the job, a small amount of common sense, and local conditions. Local conditions are mentioned, mainly for the reason that physical energy and adaptability varies in different areas, so that in changing over from one system to another, results must be compared locally.

Any of the castings which will be illustrated in this lecture are not ordered in large quantities at one time, therefore the tackle has to be curtailed to accommodate those conditions; but, on the other hand, if large quantities could be ordered at one time, additional tackle and apparatus could be set up, which would further minimise the human fatigue and also increase the saving in cost, with a relative increase in production. Even with the above limited quantities, the net cost of production of the above subjects will compare very favourably with the net cost of production of other countries where quantity production prevails.

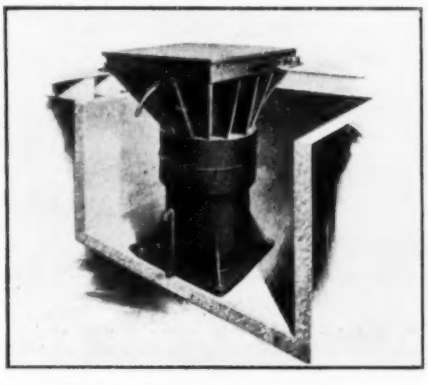


Fig. 1.—The Plain Jolt Machine.

Principles of Jolt-Ramming.

How far back the system of jolt-ramming moulds can be traced is somewhat obscure. Possibly the idea may have emanated from a grocer's shop, for the principle is quite similar to packing sugar in a bag by simply dropping a bag full of loose sugar on the counter a number of times until the sugar becomes closely packed. The resultant action may be defined as "an arrest of the force of gravity." This is exactly what happens when sand is being rammed or packed by means of jolt-ramming. Perhaps "sand-packing" would be the more correct designation, for what is actually produced by the jolting action is a mould of closely-packed sand.

Any mould can be produced by this method with more or less advantage where the pattern is of such a shape as to allow the sand an uninterrupted flow downwards. In quite a number of instances patterns which have overhanging projections can be dealt with without the necessity of printing or blocking by the aid of a certain amount of pre- or post-tucking or ramming underneath such projections.

It is essential that there should be an absence of vibration when jolt-ramming, otherwise the sand, instead of being packed evenly, will be in laminations, and is liable to flake off—more especially where flat surfaces are concerned—either in the bottom part or the top part of the mould. This can be avoided to a great extent by having good rigid patterns and pattern plates or boards. Wherever it is possible, the pattern should be fastened to the pattern plate or board. The moulding box should be securely fastened to the pattern plate, taking great care that the moulding box fits flat on the pattern plate without rocking. Briefly, rigidity and stability are absolutely necessary to obtain the best results from jolt-ramming.

Advantages of Jolt-Ramming.

There are quite a number of advantages in favour of jolt-ramming. A mould or core can be produced of fairly even density, for the sand is packed evenly all about the pattern or core box, being tight on the face of the pattern or core box, and gradually becoming less dense the further the sand is away from the pattern or surfaces of the core box. This should commend itself, for it is too well known how disastrous is the result of uneven hand ramming, with its evils of hard and soft spots near to the face of the mould or core. It interferes with the natural escape of the gas which is set up during the filling of the mould. Additionally, it causes scabs of various sorts, and sometimes local strains. Jolt-rammed moulds are naturally self-venting, and further, it is not necessary (provided that the sand is of the correct temper) to use a vent wire, as is so often the case with hand-rammed moulds, for the regular packing of the sand makes it self-venting. As a proof of this, a large mould, especially a dried mould, is a mass of blue flame all over the box after being cast, although a vent wire has not been used; this shows that the pore spaces must be in quite natural positions.

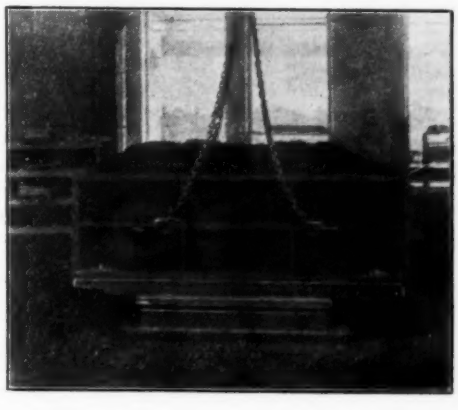


Fig. 2.—Box on Machine showing Overhang.

Castings produced by jolting are of a more uniform size and considerably better in appearance. As many castings previously made by hand moulding would need priming before painting, so as to give a nice enamelled appearance, now similar castings produced on the jolt machine do not need priming, for, speaking generally, they have good level surfaces. In fact, as the surface and the appearance of the pattern, so can this be reproduced in the casting.

Again, from the humane point of view, the saving in that most fatiguing work of hand ramming is nearly 100 per cent. When one considers that for every blow given whilst peg ramming there is used a force equal to 5 ft.-lbs. of energy,

* A Paper read before the Lancashire Branch of the Institute of British Foundrymen, Mr. R. A. Miles presiding.

and at the same time a dead weight of 6 lbs. has to be lifted. It is interesting to note that it is sometimes necessary to lift a rammer several thousands of times to complete the ramming of some moulds. The jolt machine almost eliminates this fatiguing work, for, with the exception of butting off or flat ramming, the machine will accomplish in a far more satisfactory manner in one minute or less what otherwise might take a man several hours to accomplish by ordinary hand ramming. The larger the box the more this fact is brought in evidence. No mould that is rammed entirely by the jolting method should take longer than 60 seconds to ram the mould, whether for iron, brass, aluminium, or even steel.

Another great advantage of jolt ramming is that castings are less liable to develop blowholes. This comparison is taken assuming that both the hand-rammed mould and the jolt-rammed mould are prepared with sand of the same moisture content, and that the temperature of the molten metal in both cases is similar. Any number of castings can be produced similarly alike in weight or quality, once the necessary number of jolts has been determined so as to give the necessary density to the mould. This density can generally be predetermined after a very short acquaintance with the jolting method.

A great point in favour of the jolt machine has reference to moulding boxes, whereby quite a large range of sizes of boxes can be accommodated on

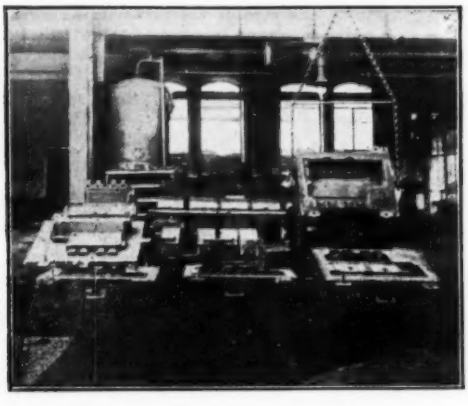


Fig. 3.—Wallis Tractor Moulds.

By using the jolter for this job 60 per cent. in cost and 150 for gains in production were shown. Three moulds are made in 8 hours.

one size of machine, varying from boxes any size less than the size of the machine table, to boxes 50 per cent. larger, or even more than this, above the size of the table, thereby making it possible for several gangs of men on different sizes of boxes to make full use of the one machine without having to use any adaptors or other contrivances which are necessary on some other types of machines when changing the sizes of boxes.

Types of Machines and Installation.

There are several types of jolt machines in use, the simplest and most versatile being the plain jolt machine such as is shown in Fig. 1. This machine takes a 30-h.p. motor and a compressor developing 300 cub. ft. of air per min. The machine consumes 213 cub. ft. of air per jolt. The diameter of the cylinder is 20 in., the stroke 2¼ in., and the size of the table 6 ft. by 5 ft. It is capable of lifting 10 tons at 100 lbs. per sq. in. pressure.

There are also several machines which have pattern-drawing arrangements, and also arrangements for turning or rolling the mould over after it has been rammed.

In considering the installation of a jolt-ramming plant, there are many factors which control the selection of the most suitable type of machine or machines. One can sometimes see lying derelict large machines of an elaborate type, owing to the wrong type of machine having been installed. Possibly the machine was thought suitable for a special job, but was unable to be kept fully occupied owing to insufficient quantities being required. Here a machine of another type would have embraced a sufficient variety of work to keep it fully occupied. The class of labour that is intended to operate the machine is an important factor, for, although the writer's work is all produced by skilled labour, with the most satisfactory results, work can be produced quite satisfactorily with semi-skilled labour, provided that the class of work and other conditions are made suitable. It does not necessarily follow that semi-skilled labour will always prove the most economical, for several instances are in evidence where it has proved considerably more economical to employ the best of skilled labour.

Perhaps the primary factor in considering jolt-ramming is the stability of the foundry buildings, for the earthquake which is set up when a fair-sized plain jolt-rammer is working is very considerable, and sometimes travels much farther than the foundry. Several instances of this have occurred, and the effects have caused a considerable amount of expense to remdy.

The cost of installing a jolt-ramming plant will compare very favourably with other types of power press and squeeze machines, with the advantage of versatility in favour of the jolt machine.

The position of the machine or machines in the building is also of great importance, for in the case of the plain jolt machine, which is simply a ramming apparatus, much valuable time can be

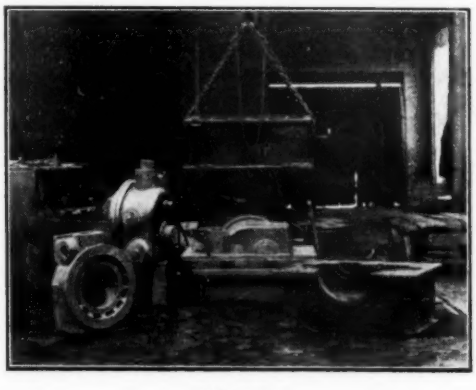


Fig. 4.

Cylinder end casting. This casting requires 60 jolts for making. The method shows 50 per cent. and 100 per cent. gains on cost of production respectively.

wasted by the unnecessary conveyance of moulds and materials.

Lay-Out and Tackle.

Lay-out and tackle should be very carefully studied, as on these items the success of the plant largely depends. Sand-preparing, conveying and lifting facilities, proximity to drying stoves and cupolas and moulds bedded in the floor, pattern and moulding-box accommodation, convenience for the safe-keeping and easy access of all small tools and tackle, pattern and pattern-plate lifting apparatus, loose pieces, etc., require careful consideration.

Moulding boxes should be of definitely rigid construction, not necessarily of heavy section, but designed specially with a view of obtaining a combination of the maximum of rigidity with a minimum of weight. This is very important, for vibration must be minimised to the utmost degree, for here is quite a common cause of many failures, more especially where the design of the pattern is inclined to have flat surfaces.

Vibration has been mentioned previously, but has been purposely mentioned again for the purpose of emphasising this point. Wherever possible, cast the moulding boxes in one piece, although quite successful results can be obtained with boxes built of loose plates, provided that after bolting the box sides and ends together, holes are drilled and fixed dowels inserted in those flanges where the box sides and ends have been joined. Wherever possible, it is advisable to plane or mill the joints of moulding boxes where the joints have to rest on the pattern-plate or board. This outlay will be amply repaid. Pro-

jections on the inside of boxes, such as bolt heads or nuts, such as are encountered when fastening loose bars, are not desirable, for the projecting nuts interfere with the flow of the sand and cause weak places, which are liable to cause the sand to fall out of the box, as in the case of a top part which has to be turned over.

Built boxes are not recommended for top part boxes, but should this be necessary, then the better alternative to bolting in loose bars is to cast a series of lugs along the box side and arrange for a slot, cast vertically in each lug, as this then makes it possible to have flat plates for the box bars, which can then be fastened into position by means of iron wedges.

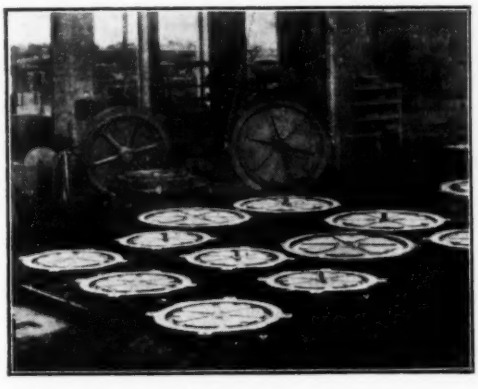


FIG. 5

Small flywheel castings. With 6-h.p. jolting machines 59 per cent. cost and 145 per cent. production gains were registered. Transferring to 9-h.p. machines, the figures were lowered to 57.5 and 135 per cent. respectively.

Loose, steady or registering pins can be used, but where fine limits are concerned, such as with very thin sections of metal and perfectly accurate joints, fixed pins are more satisfactory. In any case, fixed pins should be used for registering the moulding box on the pattern plate.

The standard limits of clearance between pin and pin hole is 0.015 in. for the 1¼-in. pin and 0.005 for the ¾-in. pin. These two sizes of pins have proved quite equal to accommodating quite satisfactorily the smallest size of box as well as the largest.

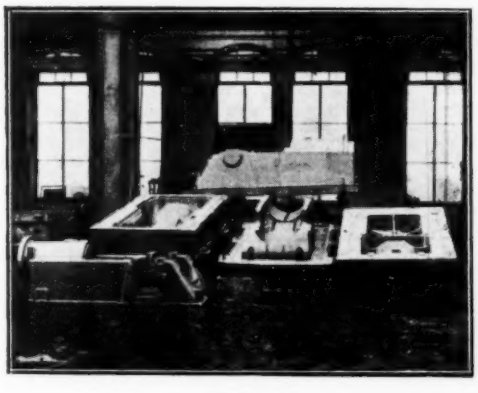


FIG. 6.

Group of G.R. bed tackle. The bottom half is given 45 jolts to the top 60. The box is 8 ft. x 3 ft. 6 in. x 2 ft. 10 in. A production gain of 88 per cent. is shown.

Any less clearance than that mentioned for the 1¼-in. dia. pin has been found to give trouble in assembling the top and bottom boxes, especially in the case of stove-dried moulds, as the difference in size and weights of the top and bottom box affects the expansion and contraction sufficiently to cover up the small amount of clearance in the box pins. Cotters have proved both very effective and expeditious as a means to fasten the moulding box to the pattern plate or board.

For mounting patterns, either plates or boards can be used, the choice of which can be readily determined after a short acquaintance with the jolt-ramming process. Boards are to be preferred, wherever possible, mainly on account of their portability, while, on the other hand, C.I. plates for the heavier boxes are advisable. The difference in the initial cost is not great, while the difference in durability is considerably in favour of the C.I. plate. Flat plates or boards are not ideal, as any sand which may cling to the underside of the plate, or which may have gathered unnoticed on the jolt table, will prevent the plate from resting flat on the table, such conditions are liable to cause vibration. A lighter and much more rigid plate can be made by means of webbing the plate on the underside. This is an advantage in cases where the pattern plate overhangs the table, as shown in Fig. 2.

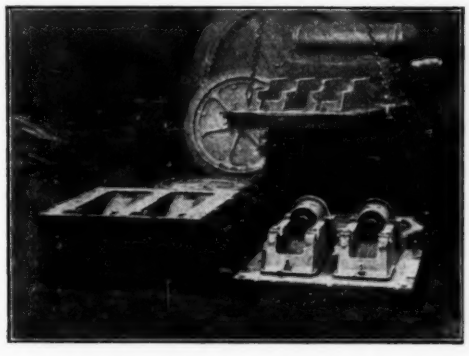


FIG. 7.—TWIN BED CASTING.

By jolt ramming 66 per cent. cost gain and 200 per cent. production gain were shown.

Patterns which are to be moulded by jolt-ramming should be strongly constructed, for the duty of the pattern is very trying. Blocking-up or printing-up overhung parts on patterns should be avoided as much as possible. This can be overcome by a very small amount of extra hand-ramming, which results in an improved appearance on the casting than otherwise would have been had core prints been resorted to. It is generally known how unsightly core-marks show up on the face of a casting unless the joints of the core and the mould are very carefully stopped in.

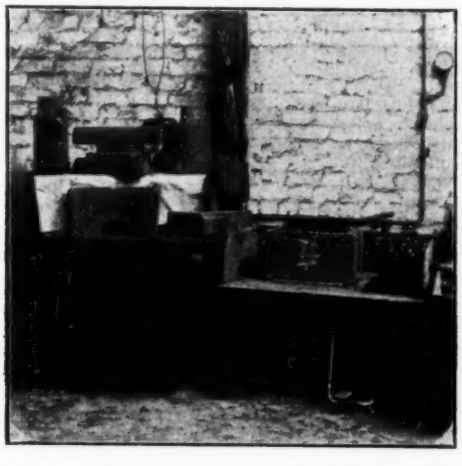


FIG. 8.—CORES AND A CORE JOLTING MACHINE.

The condition and temper of the moulding sand plays a very important part in the success of jolt-ramming. Sands of a sharp nature flow easier than sands which are of a woolly or tough nature. These differences can be more or less regulated by judicious tempering; therefore, this is a very important factor to control, for in all cases the drier the sand used, the nearer natural flow is realised.

In conclusion, the author wishes to thank his firm for courtesies extended and to Mr. Brierley for help in the preparation of the illustrations.

Some Experiments on Cast Iron.*

By J. W. Donaldson, B.Sc., A.I.C.

The behaviour of cast iron used in the manufacture of certain parts of the larger types of Diesel and internal-combustion engines is of extreme importance to engineers. The range of temperature to which parts such as piston-heads are subjected varies considerably, sometimes attaining 600 deg. C. The effect of low-temperature heat treatment on the properties of cast iron is, therefore, a subject well worth the attention of iron-founders, metallurgists, and others engaged in the manufacture and use of these castings.

During the last few years one or two Papers have been published dealing with this subject, and valuable information has been obtained. Hurst† has shown that, with commercial cast iron heated to 575 deg. C. to 600 deg. C. for 48 hours and allowed to cool slowly, a fall in tensile strength takes place, accompanied by a slight increase in impact value. Decomposition of pearlitic carbon is produced, and is nearly complete in irons containing more than 2 per cent. of silicon when heated in this manner. Schuz,† in experiments made to determine the temperature at which pearlitic grey iron is decomposed into ferrite and temper carbon, shows that for an annealing period of 24 hours the decomposition of the carbide commences at 500 deg. C. and is complete at 600 deg. C. For a six hours' annealing the action commences at 550 deg. C. and is complete at 650 deg. C., while with an annealing period of three hours the decomposition begins at 575 deg. C. and is complete at 650 deg. C. Campion and the author,‡ in tests made on grey cast irons of different compositions, show that annealing for periods of four hours produces no change until over 300 deg. C. is attained, when the strength decreases. Tensile tests made at temperatures up to 700 deg. C. show the strength to be maintained to 400 deg. C., after which it falls off rapidly. The strength, after repeated heatings and coolings to 450 deg. C. and 550 deg. C., falls off to the extent of 25 per cent. in the poorer qualities of iron and 15 per cent. in the higher qualities.

Table I.—*Chemical Analysis and Tensile Strengths.*

Mark.	P.	M.	C.	N.
	%	%	%	%
Graphite Carbon	2.48	2.55	2.24	2.50
Combined Carbon	0.68	0.77	0.93	0.67
Total Carbon ..	3.16	3.32	3.17	3.16
Silicon	1.48	1.52	1.40	1.56
Sulphur	0.054	0.014	0.04	0.095
Phosphorus ..	0.704	0.706	0.686	0.673
Manganese ..	0.97	2.43	0.973	0.943
Chromium ..	—	—	0.392	—
Nickel	—	—	—	0.746
Tensile strength as cast .. Tons per sq. in.	16.6	17.6	18.4	16.8

The effect of the addition of special elements to cast iron has also engaged the attention of various investigators. The results of the experiments are dealt with collectively in Hatfield's chapter on "The Influence of Other Elements Upon Cast Iron" in his book on "Cast Iron in the Light of Recent Research," in Campion's§ Paper on "Influences of Some Special Elements on Cast Iron," and in Smalley's‖ Paper on "Special Cast Iron." All these investigations have dealt with the effect of the special elements on the strength, hardness, structure, and casting properties of cast iron, there being practically no data as to how the irons behave under heat treatment.

The present experiments were carried out with a view to determining what effect low-temperature heat treatment had on a good cylinder iron and on irons of similar composition containing small additions of various elements.

The chemical analyses of the irons, together with their tensile strengths as cast, are shown in Table I. All the irons were cast at approximately the same temperature from cupola metal re-melted in a crucible and cast into dry-sand moulds 14 in. by 1½ in. dia., placed vertically. In the case of the special irons, the various ferro-alloys were added to the metal in the crucible. All test-bars broken during the experiments were machined bars of 0.5 sq. in. sectional area.

Table II.—*Heat Treatment Experiments at 450 C.*

Cast Iron.	Duration of Heating in Hours.	Total Carbon.	Combined Carbon.	Tensile Strength at 15 C.	Brinell Hardness.
P.	0	3.16	0.68	16.6 tons	223
	40	3.17	0.64	16.25 ,,	212
	80	3.17	0.48	15.7 ,,	197
	120	3.19	0.43	15.3 ,,	183
	160	3.13	0.38	15.4 ,,	183
	200	3.15	0.38	15.5 ,,	179
M.	0	3.32	0.77	17.6 tons	223
	40	3.29	0.74	—	217
	80	3.31	0.73	16.8 ,,	197
	120	3.35	0.55	16.5 ,,	183
	160	3.28	0.56	—	183
	200	3.33	0.54	16.4 ,,	183
C.	0	3.17	0.93	18.4 tons	248
	40	3.18	0.90	17.9 ,,	235
	80	3.17	0.85	17.5 ,,	212
	120	3.18	0.72	17.4 ,,	207
	160	3.16	0.69	17.2 ,,	201
	200	3.20	0.69	17.3 ,,	207
N.	0	3.16	0.67	16.8 tons	223
	40	3.18	0.18	16.0 ,,	167
	80	3.18	0.09	14.8 ,,	159
	120	3.16	0.08	14.8 ,,	159
	160	3.17	0.07	14.7 ,,	156
	200	3.15	0.07	14.7 ,,	149

Table III.—*Heat Treatment Experiments at 550 C.*

Cast Iron.	Duration of Heating in Hours.	Total Carbon.	Combined Carbon.	Tensile Strength at 15 C.	Brinell Hardness.
P.	0	3.16	0.68	16.6 tons	223
	40	3.13	0.12	15.8 ,,	138
	80	3.16	0.11	15.1 ,,	129
	120	3.15	0.09	14.8 ,,	129
	160	3.15	0.12	14.6 ,,	125
	200	3.14	0.12	14.8 ,,	129
M.	0	3.32	0.77	17.6 tons	223
	40	3.36	0.69	16.4 ,,	187
	80	3.30	0.46	16.1 ,,	171
	120	3.35	0.27	15.4 ,,	159
	160	3.35	0.25	15.2 ,,	148
	200	3.34	0.26	15.4 ,,	148
C.	0	3.17	0.93	18.4 tons	248
	40	3.16	0.57	17.9 ,,	207
	80	3.22	0.53	17.4 ,,	171
	120	3.20	0.49	16.8 ,,	165
	160	3.15	0.51	16.4 ,,	171
	200	3.21	0.49	16.4 ,,	165
N.	0	3.16	0.67	16.8 tons	223
	40	3.19	0.15	16.3 ,,	163
	80	3.20	0.05	13.8 ,,	138
	120	3.14	0.05	13.4 ,,	134
	160	3.20	0.04	12.9 ,,	129
	200	3.15	0.02	13.4 ,,	129

In the first series of experiments five bars of each iron were heated in an electric resistance furnace to a temperature of 450 deg. C. for eight hours, allowed to cool overnight, then reheated the following day for the same period. At the end of every 40 hours' heating, or five days, a test-

* A Paper presented to the West of Scotland Iron and Steel Institute and printed in their Proceedings.

† "Engineering," 1919, Vol. 108, pages 1-3.

† "Stahl und Eisen," 1922, Vol. 42, pages 1484-1488.

‡ Proceedings of Institute of British Foundrymen, 1921-22, Vol. 15, pages 211-231.

§ "Foundry Trade Journal," September, 1918, Vol. 20, pages 467-470.

‖ "Foundry Trade Journal," December, 1922, January, 1923, Vol. 26, pages 519-522; Vol. 27, pages 3-6.

bar was removed and its composition as regards total and combined carbon determined, together with its tensile strength and Brinell hardness. The results obtained are given in Table II.

In the second series of experiments, the same procedure was followed, excepting that the bars were heated to 550 deg. C. instead of 450 deg. C. The results of these experiments are given in Table III.

A third series of experiments was carried out to determine the strength of the cylinder iron P. at elevated temperatures. A set of bars in the cast condition was broken at temperatures ranging from atmospheric to 600 deg. C. A second set, previously annealed for four hours at 300 deg. C., was broken over the same range. A third set was annealed at 450 deg. C. for 200 hours, and a fourth set at 550 deg. C. for 200 hours before breaking. In carrying out these experiments the bars were heated in an electric resistance furnace fixed on the testing machine, the temperatures being determined from thermo-couples fixed at the top and bottom of the bars. Each bar was maintained for half an hour at the temperature determined on before breaking. The results obtained are given in Table IV and Fig. 1.

TABLE IV.—*Strength at Elevated Temperatures.*

Temperature.	As Cast.	Annealed for 4 hours at 300° C.	Annealed for 200 hours at 450° C.	Annealed for 200 hours at 550° C.
	Tons per sq. in.	Tons per sq. in.	Tons per sq. in.	Tons per sq. in.
15° C.	16.6	16.8	15.5	14.8
100° ,,	16.1	16.5	14.9	13.8
200° ,,	15.8	16.7	14.5	13.6
250° ,,	15.2	—	—	—
300° ,,	14.9	16.7	13.8	12.4
350° ,,	15.7	—	—	—
400° ,,	16.5	17.1	13.0	11.0
500° ,,	15.1	15.8	12.2	10.4
600° ,,	11.7	12.0	7.6	4.8

Consideration of the results obtained in the first two experiments shows that repeated heatings and coolings at temperatures of either 450 deg. C. or 550 deg. C. for prolonged periods produce changes in the various irons. In each case the carbide is decomposed, the tensile strength falls off, and the Brinell hardness decreases. The degree of change varies for the different irons, and is more marked at 550 deg. C. than at 450 deg. C. In Table V a summary of the results is given, showing the time required to produce stability and the percentage decrease in the combined carbon, tensile strength, and Brinell hardness at the end of that period.

crease in the manganese, but to a greater extent, by rendering the carbide still more stable both at 450 deg. C. and 550 deg. C. Chromium appears to affect the carbide in a similar way to manganese by crystallising with the carbide. The percentage decreases in tensile strength which take place at 450 deg. C. and 550 deg. C. respectively are similar to those obtained with the cylinder iron. The chromium iron, however, has a higher initial tensile strength, and even after prolonged heating at 550 deg. C. the final tensile strength is similar to that obtained in the cylinder iron as cast.

Influence of Nickel.

The addition of nickel produces little effect on the iron in its cast condition, but has a marked effect when the iron is heated even at 450 deg. C. It produces at this temperature rapid decomposition of the carbide to the extent of 87 per cent., and at the higher temperature decomposition is almost complete.

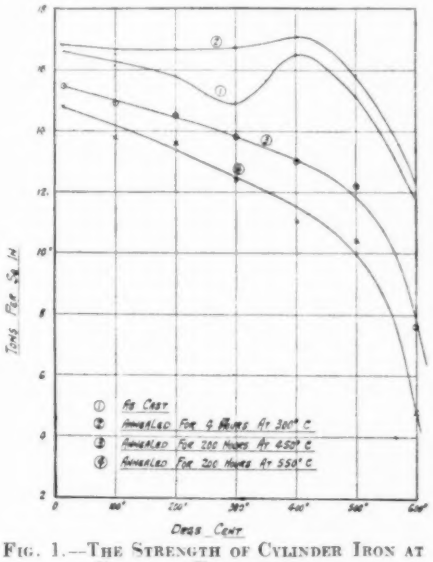

TONS PER SQ. IN.
DEGS. CENT.
① As Cast
② Annealed For 4 Hours At 300° C
③ Annealed For 200 Hours At 450° C
④ Annealed For 200 Hours At 550° C

FIG. 1.—THE STRENGTH OF CYLINDER IRON AT ELEVATED TEMPERATURES.

The experiments carried out on the strength of the cylinder iron at elevated temperatures show that if an iron is to be used for purposes in which it is heated to temperatures of 450 deg. C. and 550 deg. C., such as may occur in the piston-head of an internal-combustion engine, the tests

TABLE V.—*Percentage Changes Produced by Heat Treatment.*

Cast Iron.	450° C. Duration of Heating in Hours.	450° C. Combined Carbon Decrease %	450° C. Tensile Strength Decrease %	450° C. Brinell Hardness Decrease %	500° C. Duration of Heating in Hours.	500° C. Combined Carbon Decrease %	500° C. Tensile Strength Decrease %	500° C. Brinell Hardness Decrease %
P.	120	34	7	18	40	82	11	42
M.	120	27	6	18	120	67	12	33
C.	120	24	5.5	16	80	46	11	31
N.	80	87	12.0	30	80	94	18	40

On heating the cylinder iron at 450 deg. C., decomposition of the carbide takes place to the extent of 34 per cent., and is complete after 120 hours' heating. Further heating produces no additional change. This decomposition of carbide is accompanied by a decrease in tensile strength of 7 per cent., and in Brinell hardness of 18 per cent. Heating to 550 deg. C. causes the carbon to decrease to the extent of 82 per cent. after 40 hours' heating, with a corresponding falling-off in tensile strength and Brinell hardness of 11 per cent. and 42 per cent. respectively.

Increasing the percentage of manganese in the iron from 0.97 per cent. to 2.43 per cent. appears to increase the stability of the carbide. The manganese probably forms manganese carbide, which crystallises with the iron carbide, forming a double and more stable carbide.

Influence of Chromium.

The effect of the addition of the small amount of chromium, 0.392 per cent., is similar to an in-

obtained in its cast condition cannot be taken as representative of the strength of the iron.

Referring to Fig. 1, the curve of tensile strength of the iron in its cast condition shows a minimum at 300 deg. C. and a maximum at 400 deg. C. A short annealing at 300 deg. C., such as castings are frequently subjected to, gives a slightly improved tensile strength and a more uniform curve. The maximum tensile strength of 17.1 tons per sq. in. occurs at 400 deg. C. Subjecting the iron to repeated heating and cooling for 200 hours at 450 deg. C. and 550 deg. C. produces, as previously indicated, changes in the composition of the iron, with the result that when the iron is tested at elevated temperatures, a considerable diminution in strength is found. Tested at 400 deg. C. after prolonged heatings at 450 deg. C. and 550 deg. C., tensile tests of 13.0 and 11.0 tons per sq. in. are obtained. These represent decreases of 21 per cent. and 27 per cent. respectively on the strength obtained at the same temperature when tested in the cast condition.

Conclusions.

The conclusions to be derived from the foregoing experiments may be briefly stated as follows:

1. Low-temperature heat treatment of cast iron produces decomposition of the carbide, with corresponding decreases in the strength and hardness. The amount of decomposition varies with the temperature and increases with increasing temperature.

2. Increasing the manganese content of the iron produces a more stable carbide with less tendency to decompose when heat treated.

3. The addition of a small amount of chromium has a still greater effect in stabilising the carbide.

4. Nickel in small quantity diminishes the stability of the carbide and produces rapid decomposition on heat treatment.

The author desires to thank the directors of Messrs. Scotts' Shipbuilding and Engineering Company, Limited, Greenock, for permission to publish the data obtained in the experiments.

Institute of British Foundrymen.

NEWCASTLE BRANCH—(Junior Section).

At a meeting of the Junior Section, held on Saturday, March 15, Mr. J. D. Nicholson read a Paper entitled "Green Sand Moulding."

In opening his lecture, Mr. Nicholson said he proposed to confine his remarks to Erith loam, which was used extensively on the North-East Coast.

The mixing of sands was described, and the lecturer emphasised the importance of the correct ratio of water to sand. The ill-effects of hard and soft ramming were also touched upon, and he said that the ideal to be aimed at, in all cases, was "sound" ramming, due regard being paid to permeability and venting qualities. He pointed out the necessity for efficient venting, especially with small castings, and said that blowholes, sometimes caused by insufficient venting, were visible often only when the casting was being tested and after much machining had been done.

The finishing of a green sand mould required care and lightness of touch. Too much clay water should not be applied to the iron or grates when repairing bad lifts, as this would cause the sand to become overburdened, making it dense, and liable to peel off. As a preventive of this, plumbago could be rubbed over the mould face, the gases from the plumbago acting as a screen to resist the scorching effect of the iron.

The lecturer also touched upon the method of moulding with skeleton pipe patterns, which was illustrated by means of sketches.

Dealing with the question of runners, he pointed out that, owing to their length and thickness, pipes were more satisfactorily run with several small runners, as this would eliminate the danger of the metal failing to completely fill the mould.

In conclusion, he said that successful green sand moulding depended largely upon the "touch" of the moulder, and that could be acquired only by experience.

The Paper aroused an exceptionally good discussion, after which a hearty vote of thanks, proposed by Mr. C. Boudry and seconded by Mr. J. G. Miller, was accorded to the lecturer for his excellent Paper.

The imports of foreign iron ore at the Senhouse Dock at Maryport last week amounted to 3,500 tons.

The Atlas Engineering Company have removed their showrooms from Bridge End, Leeds, to their works at Gateshead.

The municipality of Copenhagen has just placed a very large contract for complete boiler-house equipment for the municipal electric power supply station with Vickers Spearing Boiler Company, Limited, London, an affiliated company of Messrs. Vickers, Limited. The contract includes boilers of 2,000 h.p. each, with economisers, stokers, air heaters, superheaters, mechanical stokers and all accessories. The whole of this plant will be manufactured in Great Britain. The contract was obtained in open international competition.

A Ridiculous Action.

At Walsall County Court, George Faulkner, caster, claimed £37 11s. 2d. from Messrs. Sydenham & McOustra, ironfounders, Chuckery, being money which he alleged had been improperly stopped from his wages.

Mr. T. P. Haslam (for plaintiff) said that from August, 1921, a sum of 7s. 6d. weekly was deducted from Faulkner's wages, and this continued until he left the firm's employment last year. Faulkner objected, but was told by Mr. Fox, the manager, that he (Fox) had been buying iron heavily, and that the workmen had got to help bear the loss. In evidence, Faulkner said the reason he went on working for the firm after the deductions had been made was that he lived in a house belonging to Fox, and was afraid to resist what was being done. For the defence, Mr. D. L. Finnemore called evidence to show that a reduction of wages was enforced owing to the selling price of castings having fallen considerably. The matter was discussed with representatives of the workmen, Faulkner being one of the number, and they were told it was a case of accepting or leaving. Subsequently a notice of the reduced rates was posted up in the works.

Judge Tebbs said it was the most extraordinary claim he had ever encountered. It came very near to being blackmail, although of course it was not actually so. There was, however, a way of extorting money from people which was frequently practised in the Courts. It was only necessary for a man who had no means to bring an action to get the person sued to give him money to discontinue it, because it cost less to do that than to defend an action.

Giving judgment, his Honour said he did not know why such an action was ever brought; he doubted whether plaintiff was the author of it. His claim was based on the fallacy that after remaining in the firm's employ until 1923 he could recover wage deductions made in 1921. Somebody, no doubt, suggested that to him, but if it had been a High Court action, in which there had to be pleadings, it would have been struck out for failure to disclose any cause of action. It was obvious plaintiff's wages could be reduced at any time on a week's notice being given to him, and he could either take it or leave it. He could not take it and then afterwards sue for the difference. To bring an action under those circumstances was too ridiculous to think about.

On the evidence, his Honour had come to the conclusion that the deduction from plaintiff's wages was improperly made during the first fortnight, and he gave plaintiff judgment for 15s. with costs. He added that he had no power to order plaintiff to pay the costs, and the result was that the unfortunate employer, who practically succeeded, would have to pay quite a large bill of costs. In a case of that kind there was a duty on solicitors not to bring an action where there was no cause for it, and in that instance he did not think the duty had been carried out. Mr. Finnemore suggested that an order might be made diminishing plaintiff's costs, but the Judge said he was powerless. It was not because his sympathies were not with the employer that he did not accede to the application.

The Vulcan Foundry Company, Newton-le-Willows, are supplying twenty 2-8-0 locomotives for the Bengal-Nagpur Railway, twenty 0-6-0 tank locomotives for the Midland Section of the L.M.S.R., fifty G2 class locomotive boilers for the L. and N.W. Section of the L.M.S.R., twenty No. 10 standard boilers for the G.W.R., two boilers for the Madras and Southern Mahratta Railway, and two boilers for the Iraq Railway.

Nasmyth, Wilson & Company, Limited, Bridgewater Foundry, Patricroft, Manchester, recently supplied 25 boilers to the East Indian Railway, and are at present engaged upon the manufacture of three 4-8-0 locomotives and tenders for the Nigerian Railways, four boilers for the South Indian Railway, and four for the United Railways of the Havana. Ten tank locomotives and five locomotives and tenders are being supplied to the Great Northern Railway (Ireland).

Recent Innovations in the Metallurgical Microscope.

Realising the invaluable part the microscope plays in research work, our representative recently had the pleasure of examining the principle and application of apparatus under the above heading. A marked step in progress has been made in various directions, which will materially help all who are engaged in foundry work and metallurgical work generally. Dealing with the super-microscope first, the principle embodied in this constitutes a novel method of eye-piercing. The eye-piece and objective together are utilised as a single unit to magnify the image formed by another objective. By interposing another lens system between the two objectives, the image formed by the main or primary one is brought lower down the tube, and it is this image which is magnified by the secondary microscope which now becomes the eye-piece.

The principle is shown in Fig. 1.

The collector may be considered to be an outlying portion of the primary objective, and the facts which emerge from the application of this principle are varied and of considerable interest and clearly demonstrable.

(1) In low or medium power work a field and depth of focus not possible at the same magnification employed in the usual way. This is attained by the use of low-power objectives for comparatively high magnification, *e.g.*, 250 dias. with ½-in. objective or 100 dias. with a ⅔ in.

(2) In high-power work, higher magnification on any given objective than would be thought advisable to use in the ordinary way, and this high magnification is not gained at the expense of resolution, *e.g.*, 1,000 dias. with a ⅛-in. objective.

(3) In photography no eye-piece is necessary up to 2,500 dias. at least. No long extension camera is needed, and the exposures are shorter.

(4) Wide range of magnification, ranging from 50 to 7,500 dias., is possible, and has actually been done with the same apparatus.

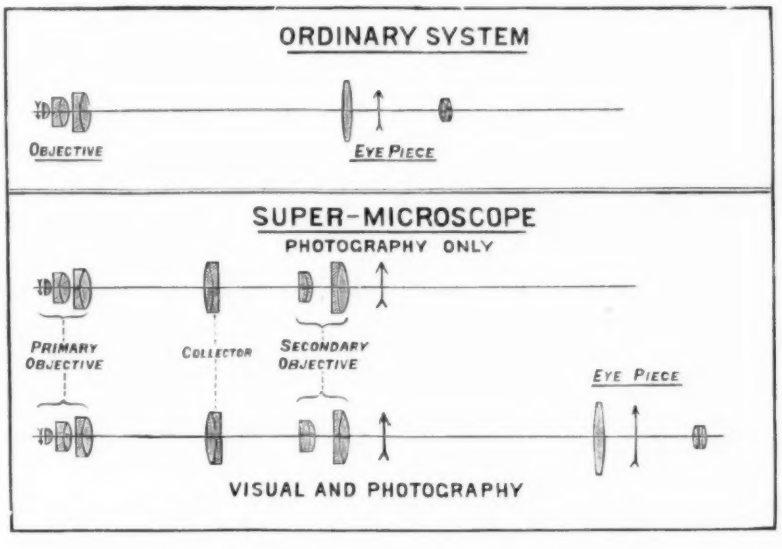


Fig. 1.—Illustrating the Difference between the Ordinary and the Super-microscope System.

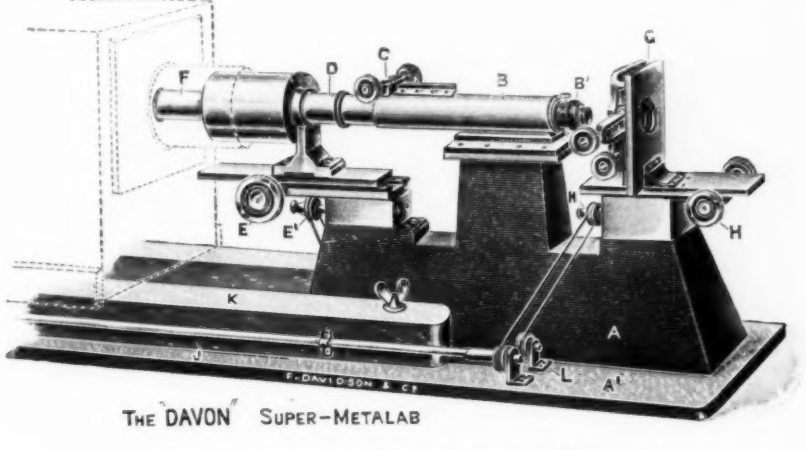


Fig. 2.—An Optical Bench Capable of Working to 7,500 Dias.

(5) The principle lends itself particularly well to photographic apparatus constructed for rapid repetition work in those busy works or laboratories where numbers of photographs at a fixed magnification are wanted. Apparatus which does not need expert operators, and in which photography becomes semi-automatic.

(6) Variable magnification is possible without altering the optical system. This is obtained

within certain limits by altering the distance between the collector and the primary objective.

From the foregoing it will be readily understood that the super-microscope possesses so many advantages over the ordinary microscope that it should be installed in all works where proved up-to-date methods are appreciated.

Dr. Rogers, President of the Sheffield Metallurgical Association, has devoted a good deal of time to investigation and, being satisfied as to the soundness of the principle, has himself designed apparatus which would allow the full benefit to be obtained from it.

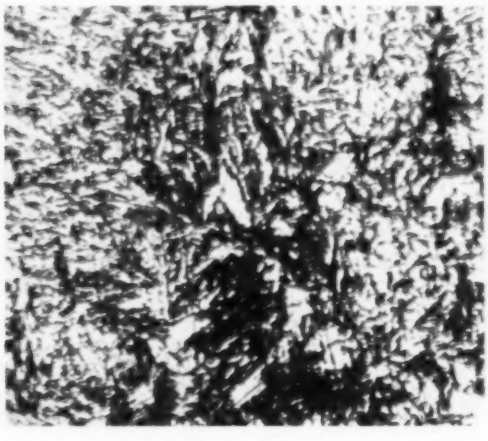


FIG. 3.—NICKEL-CHROME STEEL AT 1,000 DIAS. TAKEN WITH A 1/6-IN. OBJECTIVE BY THE ORDINARY METHOD.

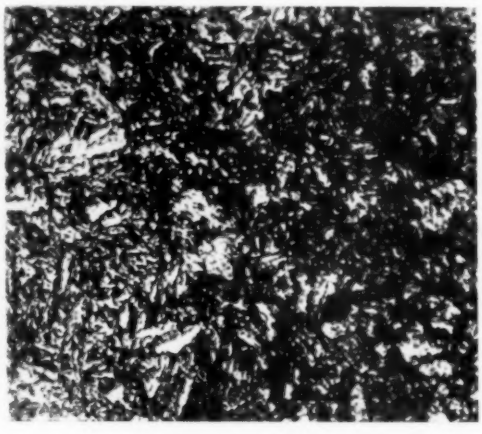


FIG. 4.—THE SAME MICRO-SECTION AS FIG. 3, BUT PRODUCED BY THE SUPER-MICROSCOPE METHOD.

The results of his investigation were read before the Sheffield Metallurgical Association in November last. Fig. 2 shows the design of the optical bench constructed under his supervision for the most critical research work, both visual and photographic and capable of being employed, as it has been, at magnifications of from 50 to 7,500 dias.

It will be seen that both the primary and secondary microscopes are built in on a solid casting "A," thus ensuring the maximum of rigidity and the maintenance of true optical alignment. "B" is the primary tube with worked

Space does not permit us to reproduce others we have seen at 5,000 dias. and beyond. We are pleased to say that the opinion expressed by Dr. Rogers has been confirmed by many other metallurgists, and we ourselves endorse it.

Fig. 12 illustrates the "Metalworks" camera designed by Dr. Rogers, in which the advantages of the super-microscope system are incorporated. It shows the following advantages:—

(1) It is possible to obtain relatively high magnification from the given primary objective: this implies—

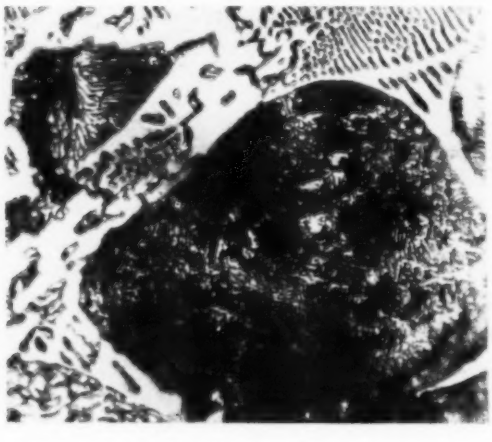


FIG. 5.—CAST IRON AT 1,000 DIAS, TAKEN WITH THE SUPER-MICROSCOPE.

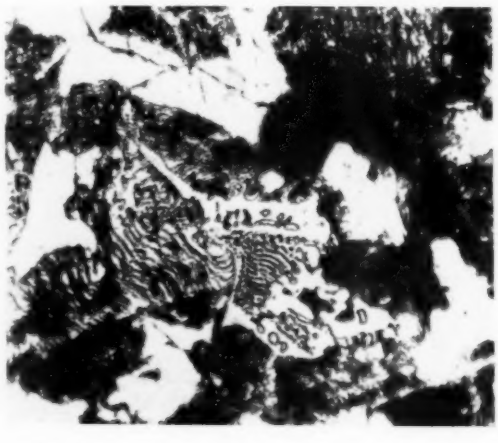


FIG. 6.—CAST IRON AT 1,500 DIAS., TAKEN WITH THE SUPER-MICROSCOPE.

cover glass illuminator "B¹." "C" is the rack and pinion for moving the "collector" tube. "D" is the secondary microscope. "E" and "E¹" the coarse and fine focussing of the secondary. "F" the eye-piece. "G" the mechanical stage with coarse and fine focussing. "H" and "H¹." The solid mahogany arm "K" (on both sides) on which the camera rests can be swung on one side to enable the operator to approach closely for visual observation.

Figs. 3 and 4 are two photographs of nickel-chrome steel at 1,000 dias., taken in both instances with a ⅛-in. objective. Fig. 3 has been taken by the ordinary method of objective, projection eye-piece and long extension camera, and Fig. 4 by the super-microscope method.

A comparison here clearly indicates the superiority of the super-microscope system.

Figs. 5 and 6 illustrate its superiority again on a specimen of cast iron.

The quality of the work is shown in high power in Fig. 7. The definition will be seen to be quite critical, rather beyond what would be possible by ordinary methods at such magnifications.

(2) the advantage of larger working distance;

(3) focussing without disturbance of either object or objective and by a coarse movement instead of the usual delicate fine adjustment, and

(4) ease and rapidity of working.

The primary objective "B" is *fixed* at its proper working distance. The specimen is placed on top of the mechanical stage "A" and requires no fixing or mounting.

In the tube "C" is the collector, and "C¹" is the focussing pinion of the secondary objective, and this is the only movement required. The

light is projected through the vertical illuminator at "B" on to a silvered card at "D," which is on a resilient bed. When the dark slide has been removed it springs back into register ready for the next picture.

Once the first specimen has been got into focus by means of the secondary "C¹" and photographed, others can be placed on the stage and photographed in rapid succession, the exact focus being maintained so long as the specimens are flat. If one is not flat, a slight turn of "C¹" will bring it into focus.

Here, then, is a camera which must be of considerable value, giving results which are ample for the majority of everyday requirements of a busy works, but not involving expert operation nor the delays which are at present customary and perhaps unavoidable.

It is constructed for a fixed magnification of either 100, 250 or 500 dias.

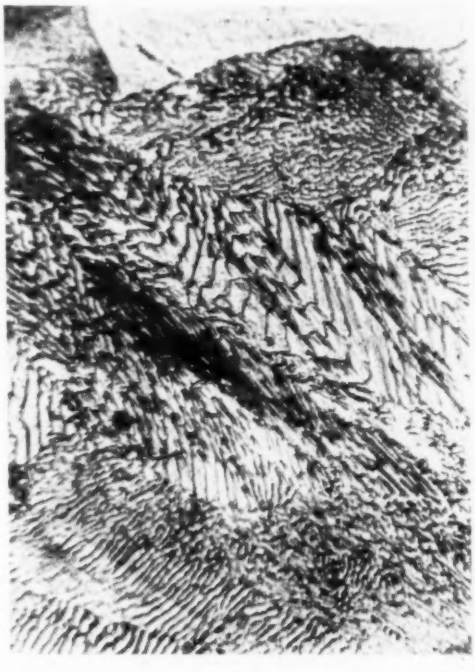
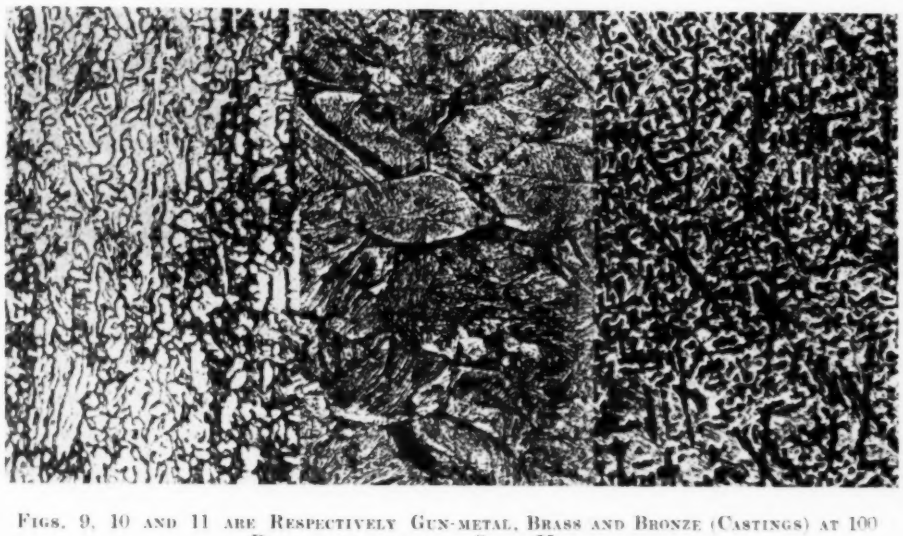


FIG. 7.—CARBON STEEL AT 1,500 DIAS., TAKEN WITH THE SUPER-MICROSCOPE.

FIG. 8.—MAGNET STEEL AT 3,500 DIAS., TAKEN WITH 1/12-IN. O.G. BY THE SUPER-MICROSCOPE.



FIGS. 9, 10 AND 11 ARE RESPECTIVELY GUN-METAL, BRASS AND BRONZE (CASTINGS) AT 100 DIAS., TAKEN WITH A SUPER-MICROSCOPE.

The Micro-Telescope.

The principle of the micro-telescope is the formation of an image of a more or less distant object on the plane of the stage of the microscope by means of a short focus telescope object glass. This image is magnified by the microscope, which in this way becomes the eye-piece of the telescope, and the result is, in a telescope so constructed, a range of observation from 6 ft. to infinity, magnification terrestrially up to 50 dias. and a depth of focus which enables one to look at an ordinary photograph and see it in apparent stereoscopic relief.

This is most valuable in works for the reading of minute scales of barometers, burettes, etc., at a distance, or for the examination of inaccessible parts of machinery, smoke stacks, etc.

Fig. 13 shows a type by means of which the combined advantages of variable magnification,

XUM

field and depth of focus can be realised for certain classes of observation and photography on which we lay great stress, namely, in dealing with fractures.

This can be employed at any distance between 1 and 3 ft., and the magnifications will vary between 25 dias. at the greater to 75 dias. at the shorter distance.

Sufficient has been said to show that the combination of micro-telescope and super-microscope

Fig. 12.—The Metalworks Camera.

attachments, which, by the way, can be adapted to most microscopes for visual work, provides a range of utility not approached by any other known instrument.

The super-microscope and micro-telescope are British inventions, and credit must be given to the patentees, Messrs. F. Davidson & Company, manufacturing opticians, Great Portland Street,

Fig. 13.—The Micro-Telescope.

London, W.1, and to Dr. Rogers, for the considerable amount of thought and work they have put into it, in order to produce an apparatus which has been conceived by many metallographers, but never before successfully constructed.

All the photographs reproduced are the work of Mr. J. D. Jacobs, one of the partners, who is to be congratulated on their excellence.

Census of Production.—At the meeting of the Royal Statistical Society on March 18, Mr. A. W. Flux, C.B., read a Paper on "The Census of Production," in which he stated that the practice of taking a frequent census of industrial production had become firmly established in the leading Anglo-Saxon countries other than our own, and was spreading in other countries. The United States had a decennial inquiry throughout the second half of the nineteenth century, changed to a quinquennial interval in the present century, and, since the war, had shortened the interval to two years. Canada, Australia, New Zealand and South Africa take a census of manufactures yearly, and Holland and Norway also began taking such censuses during the war. The long interval since the last inquiry in this country made us an exception to the general practice of the greater English-speaking peoples.

British Empire Exhibition.

Congress Programme.

Wembley, throughout the whole period of the British Empire Exhibition, is to be the scene of a series of important conferences and congresses. They will be held in the four Congress Halls which have been specially built for the purpose at the north-east corner of the grounds. Each Conference is being arranged by an appropriate Imperial or National organisation. The four Conference Halls, each of which is supplied with the necessary Committee Rooms, are now practically completed. They can accommodate respectively 120, 150, 550 and 1,800 people.

In addition to the Empire Mining and Metallurgical Congress, particulars of which were given in our issue of January 25, the following bodies (selected from the list) have now been given dates for the conferences they are arranging:—

British Engineers' Association (May 21 and 22, June 24 and 27, September 17, October 15 and 16).

British Science Guild: Science and Labour (May 30 and 31).

Chemical Association (July 10).

British Electrical and Allied Manufacturers' Association: World Power, Electrical Contractors' Association (June 30 to July 12 and June 18).

Gas Association (May 13 and 14, June 9 and 23).

Illuminating Engineering Society (August 12).

Institute of Automobile Engineers (June 23).

Institute Municipal and County Engineers (June 28).

Incorporated Municipal Electrical Association (September 17).

Institute of Transport (September 19).

Sociological Society and British Section International Association of Labour Legislation: British Empire and International Labour Legislation (July 21).

Contracts Open.

Cairo, April 15.—43,500 cast-iron weights of various dimensions, for the Physical Department of the Egyptian Ministry of Public Works. The Department of Overseas Trade (Room 48).

Durban, Natal, May 2.—(1) Fifteen large needle valves, or torpedo sluice, with operating gear, and steel or cast-iron lining for sluiceways with appurtenant ironwork; (2) travelling crane, cut-off spheres, trucks, screens, standpipes, etc.; and (3) cast-iron pipes, valves, venturimeter for sphere pumps, and cast-iron special pipes, etc., for the Corporation of Durban. Webster, Steel & Company, 5, East India Avenue, London, E.C. (Fee, £5 5s., returnable.)

Edinburgh, April 5.—Brass, copper, iron castings, iron bolts, etc., for the Corporation. The Inspector of Cleansing, 329, High Street.

London, S.W., April 4.—Cast-iron pipes, etc., for the South Indian Railway Company, 91, Petty France, Westminster, S.W.1. (Fee, 2s. 6d., not returnable.)

London, E.C., March 31.—Stores and tools, for the Burma Railways Company, Limited, 199, Gresham House, Old Broad Street, E.C.2. Mr. F. C. Franks, secretary. (Fee, 10s., non-returnable.)

Preston, April 7.—Supply and installation of dust-eliminating plant and bailing machinery at the destructor, Deepdale, for the Corporation. The Borough Surveyor, Town Hall, Preston.

Pretoria, April 14.—12-in., 14-in., and 18-in. steel pipes, for the Municipality of Pretoria. Beckett, Son & Company, Suffolk House, 5, Laurence Pountney Hill, London, E.C.4.

Sydney, N.S.W., May 7.—Three cranes of the electric overhead travelling bridge type, for the New South Wales Government Railways, Chief Mechanical Engineer's Branch. The Department of Overseas Trade (Room 50).

Wolverhampton, April 15.—5,400 yards of 15-in. and 2,950 yards of 12-in. cast-iron water mains, for the Corporation. Mr. E. A. B. Woodward, waterworks engineer, Town Hall, Wolverhampton. (Fee, £2, returnable.)

The members of the Institution of Welding Engineers met in the Lecture Theatre of the Municipal Technical School, Byrom Street, Liverpool, on Monday, when a lecture, entitled "Steel: Its Properties and their Relation to Welding," was given by Prof. F. C. Thompson, Professor of Metallurgy at Manchester University. Sir W. Peter Rylands, J.P., president of the Institution, was in the chair.

Should Pig-Iron be Bought by Fracture or Analysis?*

By Robert Buchanan (Past-President of the Institute of British Foundrymen).

Recently there has been an awakened interest in this question, partly due to the advocacy of some American friends; but really the question has always been with us to a more or less degree. More than 20 years ago the author came out boldly for analysis alone, and said that if he obtained a certain required analysis he did not care under what conditions the pig-iron was made, or what fracture the iron showed. Since then, with a wider experience, he has had to modify his views, and is not so certain of this opinion as he was then.

The subject is such a large one, and the effects on the ironfounding industry are so important, that it is very necessary for full consideration to be given to the question.

Sale and Use of Pig-Iron by Fracture.

This is the traditional British method, which has been in use since the rise of the iron trade in this country, and is much prized by many foundrymen to-day. Others use a combination of fracture and analysis. The latter is a growing practice, and has much to commend it. Of what is the particular fracture a product? This is due to the influence of a great many contributory causes. Fracture is affected by the kind of ores used—by the temperature and quantity of the blast used, the regularity of the descent of the furnace charges, the temperature at which the ores are reduced from oxide to iron, and the rate of cooling of the iron on the pig bed. These are only some of the physical causes affecting the kind of fracture.

What of the chemical causes? There is not one constituent but affects the fracture in more or less degree. Silicon, for instance, in moderate amounts, say, from 1 to 2 per cent., has the tendency to open the grade, other things being equal. When the silicon approaches 4 per cent. it closes the grade again as its usual effect. In fact, some high-silicon iron is as close as some low-silicon iron, and unless one analyses it is only a practised eye which can tell whether the closeness is due to low-silicon or to high. The author's method of deciding whether the closeness is due to low- or high-silicon when viewing the pig-iron, is that in the case of the high-silicon it has a brighter sheen on the surface, as if there were many small diamonds present. A similar closeness of fracture is duller when the silicon is low.

Definition of "Closeness" or "Openness."

Either term is really an attempt to indicate the size of the crystals of iron in the mass, as also the size of the graphite plates. On the authority of Professor Turton, F.R.S., a noted crystallographer, it can be stated that these crystals are not pure iron, and they usually have some manganese as a constituent. Another very powerful chemical influence on "closeness" or "openness" is sulphur, though the author is not in agreement with the opinion that sulphur in all its degrees is harmful. On the contrary, it is very useful in many cases. He agrees with Thomas D. West, who said there was no good iron and no bad iron; it all depended on the use to which it was to be put.

The carbon also has a marked effect on the fracture, not only from the quantity of carbon present, but also in what condition it is in, whether in the combined form or in the free or graphitic form. And, again, on whether the graphite carbon is massive or finely divided. The latter, however, is more due to the furnace conditions than to any other cause.

One could follow this reasoning as regards the manganese darkening the fracture, and phosphorus lightening it, but enough has been said on the chemical aspect so far as it affects the fractured appearance. Speaking generally, open-grained iron is weak; close-grained irons are strong. To the latter statement there are well-known exceptions even in grey varieties of pig-iron. White and mottled irons are always weaker than similar make of iron which is grey and close-grained.

Effect of Blast Conditions on Pig-Iron.

The effect, on fracture, of whether the iron is being produced in a blast furnace using cold blast, semi-cold blast (400 deg. C.) or hot blast, can be stated from experience to be that cold-blast and semi-cold blast iron generally have a closer grained fracture for a given analysis than hot blast iron. This is due to the finer divided graphite in the last two. Hot-blast iron of a given analysis has the graphite more massive than the other two irons, and thus shows more open fracture. But high-blast temperatures and rapid production have effects not discoverable by fracture or analysis. Physical tests, cleanness of melting and the finished casting provide the means known at present by which these differences can be ascertained.

Fracture, or grain structure, and analysis of two irons may agree, and yet the physical results be widely apart. This was shown years ago at Swedish blast furnaces, and they came to the conclusion that gases dissolved in the iron were the cause of the iron made at the higher temperature being weaker than that made at the lower.

To judge iron by fracture alone may be deceptive, in so far as the cooling conditions on the pig bed are unknown to the user. The hot pig-iron may, and often is, quickly cooled by a hose-pipe for quickness of handling. The result is a closing of the grain. If the blast furnaceman wanted a specially open grain, he could cover the hot pigs with a thick coating of sand, but exigencies of output will not allow that even if he wanted to. And so in the case of very large pigs which show large crystals, these, and the two cases mentioned, when melted in the cupola, will revert to their original real quality, irrespective of their original condition as pigs.

In judging pig-iron by fracture, there is plenty of room for error, but experience in mixing irons by fracture, coupled with a knowledge of the blast-furnace conditions under which the iron is produced, will help to obtain the best results within limits.

Analysis.

When analysis of pig-irons became fairly common many thought that they had come pretty well to finality as regards the quality of pig-iron and their knowledge of it. Then they supplemented analysis by using the microscope. Then they supplemented the microscope by tensile and transverse tests. Now it is proposed to supplement these aids to knowledge by using shock tests. The fact is, those interested are looking each time at a different facet of a diamond, but still the same diamond, and as yet it is not quite known what the diamond really is. Analysis is one facet of the diamond, and an important one, but it is not the whole diamond: neither is fracture. Physical tests are more important than either. For physical tests, grain structure is more important than chemical purity.

As regards analyses of pig-irons, some foundrymen have a rather pathetic faith in analysts. In the foundryman's view, or in the view of many, analysts never make mistakes. If they do not, they are unlike the rest of humanity. One could readily give instances of discrepancies between the findings of different analysts on similar samples, but not so much as one would find between different foundrymen melting similar irons.

Analysts, though not more perfect than foundrymen, yet fill a most important place in the foundry world as an aid to the knowledge of foundry materials. They are a help before the

* A Paper read before the West Riding of Yorkshire Branch of the Institute of British Foundrymen and the Keighley Engineering Society.

foundryman begins his work, and a corrective if he fails to do it right. In Keighley, foundrymen are fortunate in having a public laboratory under able management, and it says much for the enlightened view of local employers as to its usefulness to the foundry industry.

The analyst can indicate very closely the constituents of the various irons to be used, but unless the foundryman knows also the changes which will take place during the course of melting these irons, the results need not necessarily be all that is required by both maker or buyer.

Two distinguished American foundrymen, Dr. Moldenke and Mr. Walter Wood, who recently visited the country, advocated the standardisation of silicons and sulphurs principally, and in some degree the fixing of minimum total carbons. The difficulty in heavy engineering is to keep the total carbons down. The silicons our friends showed, with their related sulphurs, were wrong in the author's view. These showed the lowest sulphurs along with a related low silicon, and the highest silicon with the highest sulphur. In British blast-furnace and foundry experience, it is generally the reverse. Here high silicons connote low sulphur, and low silicon usually has higher sulphur.

Buying to Fracture and Analysis.

It is often complained of how variable in their working blast furnaces are, and undoubtedly they are very delicate giants which sometimes behave like children. They are even affected by the weather, but their variability, like a certain section of the community, is one of their charms.

What would foundrymen do if every furnace never took the "pot" and refused to change from one grade of iron? Where would the ironfounder be who had a different job to cast and had only one source of supply and one grade? It is the "infinite variety" of the blast furnace which makes the blast furnaceman tired, and conduces so much to the comfort and happiness of the foundryman.

Were buying to fracture and analysis universal, the blast-furnace people would be in for a bad time. The iron, as it comes from the furnace, may have three grades of fracture and three differing analyses from one cast. Picture the half of a pig bed being carried on a travelling crane to the pig-breaker. Where should a drilling be taken for analysis? From the pig nearest the furnace, or from the pig farthest away? Or from a mixture of these two pigs? Would either or both represent the pigs as a whole? They would not be definitely accurate.

Obviously, there has to be compromise on a general average of analyses. Thus, if one took drillings for analysis of the iron in a ship's propeller, would one take it from the boss or from the blade? Either would not represent the other. The same could be said of samples from boss and blade for miscroscopic examination. The same may be said about test-bars out from the boss and blade. The ship's propellor is given as an extreme example of what, to more or less degree, obtains in most castings for engineering purposes.

Mr. Wood's Views.

Through the kindness of Mr. J. Wood, of Wakefield, who has had a very large experience in melting irons and seeing the products tested, the author is able to put the gentleman's views on record, which are:—

> During our conversation recently on chemical analyses of pig-iron and its effect on castings, I understood that you wished to convey, that unless one knows the chemical composition of the iron one uses, and mixes it accordingly, it is next to an impossibility to get sound castings and uniform results. In other words, that judging by fracture is a sort of happy-go-lucky method.
>
> This may have been true in the old days, but since the advent of the chemist in the foundry it has been proved beyond doubt that neither the chemical composition of iron, or merely judging by the appearance of the fracture, are very reliable. What is really necessary is a common-sense application of both. To judge by either chemical composition or fracture without taking the physical properties of the iron into account is wrong, and not conducive to sound castings and uniform results

Danger of Relying Solely on Analysis.

As you are aware, we are large consumers of pig-iron, and during the time I have worked here, some twenty-five years or so, I have had the opportunity of seeing and using nearly all the important brands of pig-iron made in the kingdom, and I have made a study of the various characteristics of the different irons that have passed through my hands. To enter into details of all this at the present time would take too long, therefore I will just point out two or three cases where, if the iron had been mixed to analysis alone, serious results would have happened.

Some time ago we accepted a large quantity of iron (some 700 or 800 tons). On analysing this (several samples were taken from each consignment) the following results were obtained:—Gr. 2.25; C.C., 0.86; Si., 0.94; S., 0.048; Mn., 0.65; and P., 0.31 per cent. This iron, although of such a low silicon content, was of a very open fracture, very soft, and rather weak.

The works chemist suggested that the iron on re-melting in the cupola would come out very hard, owing to its low silicon content, and advised using it sparingly. I did not agree with him, and obtained the manager's permission to melt 10 cwts. of this iron by itself in the cupola after the day's blow. This was done. Some of it was poured into an open sand casting, a plate ½ in. thick, 3 ft. by 4 ft. The remainder was poured into castings that had to be machined and put under 400 lbs. per sq. in. hydraulic pressure. Now, had this iron acted according to its analysis, the open sand plate would have undoubtedly split whilst undergoing contraction. But the reverse happened. The plate was perfectly sound, and on being broken up for examination, showed an open-grained fracture and machined easily. The other castings also machined easily, but on being put under pressure leaked at the top part of the casting, being porous from one end to the other. This shows that the low silicon content of the iron has not the effect it is supposed to have, as the iron was neither hardened nor the grain closed to any appreciable extent.

A Second Example.

Another example which shows that it is not wise to rely too much on analysis is shown by the following:—

A consignment of pig-iron was received and several samples analysed, with the following results:—Gr., 2.75; C.C., 0.66; Si., 2.26; Mn., 0.051; and P., 1.03 per cent. This iron gave a very close, dense fracture, and taken on its fracture alone, likely to give a hard casting. But judging it from its chemical composition it should give a soft casting, with good machinability. To test the physical properties of this iron, a quantity was melted and run into test bars, moulded in green sand. The first mould was stripped soon after it was cast and the bars allowed to cool in the atmosphere. The second mould was not disturbed until the bars were quite cold. The first bars were not machinable; the second lot were machined with difficulty. This again shows that too much reliance cannot be placed on the chemical composition of the iron. The above examples are by no means isolated. Almost every week we receive consignments of pig-iron the fracture of which is not in accordance with its chemical composition and vice versa, and it would be an impossibility to obtain regular results did we rely on analysis alone.

On the other hand, it is not always advisable to rely upon the appearance of the fracture. It often happens that a close-grained iron (chemical analysis and fracture of which are in accordance), when cast, will have a more open grain than it had in the pig, and under hydraulic test, leak, thus showing its porosity. This class of iron can only be detected after careful examination, a casual glance at the fracture and one might conclude that it was an ordinary close No. 4, and would probably use it as such. But after careful scrutiny one sees the graphite flakes are extremely small, giving the fracture an appearance similar to that of a lump of fine sugar. An expert blast furnaceman explained that this is caused by the iron being rapidly cooled, which, if with a normal rate of cooling, would have an open grain. This is probably the explanation, because when re-melted and cast into a test bar or a casting of medium thickness, the grain is more open than in the original pig.

A High Strength Pig-Iron.

Another class of iron which gives remarkable physical properties, although the analysis does not warrant such, is shown by the following:—T.C., 3.25; Gr., 2.64; C.C., 0.61; Si., 1.34; Mn., 0.86; and S., 0.127 per cent. On the surface of this fracture is a fine network structure, a thin white

network, the interstices of which are dark grey. This is generally found in an iron containing a fairly high percentage of sulphur. I have not been able to satisfy myself about the cause of this particular structure, but when examined microscopically and a sulphur print taken, one might suggest a theory as to the formation of the structure. The graphitic carbon is finely divided, possibly due to rapid cooling of the metal after melting in the blast furnace. This forms the grey background, while the white portion, *i.e.*, the network appears to be high in combined carbon, and from the sulphur print it is seen to be high in sulphur, and these conditions increase the strength considerably. One can only theorise as to how this structure is formed. However, there is no doubt about its physical properties. The test bar 36 in. by 2 in. by 1 in. cast from the above iron gave a transverse load of 50 cwts. The deflection at 40 cwts. was 40 in. The machine on which it was first tested only registered up to 40 cwts. It was then transferred to a larger machine, which is not provided with a means of measuring deflection. Another bar with practically the same analysis: T.C., 3.25; Gr., 2.52; C.C., 0.73; Si., 1.23; Mn., 0.99; S., 0.122; and P., 1.02 per cent. cast with pig-iron, but without the network structure, the pig-iron gave a transverse load on 36 in. by 2 in. by 1 in. of 35 cwts. with a deflection of 0.39 in. So that, although there is very little difference in the chemical composition of these irons, there is a great difference in the physical properties.

The last figure quoted, may be considered exceptionally good by the majority of foundrymen, but they are assured that they are the rule rather than the exception at the contributor's firm. This is only brought about by a very careful selection and mixing of the brands of iron without giving too much consideration to the chemical composition.

Major Miles's Contribution.

Major Miles, of Thorncliffe Iron Works, sent the following contribution, which the lecturer read.

It is brought home to me, more than ever, that only the bold or the very ignorant would nowadays affirm a belief in purely chemical or purely physical information. The reasons for saying so are as follows :—

(1) Modern scientific research has broken down completely the barrier that existed between purely chemical and purely physical effect. One has only to bear in mind, for instance, the recent researches in molecular structure and into the activity of protons, ions, etc. Another example is the behaviour of colloids. A further example which may be of interest to foundrymen is that Professor Wheeler has shown that neither CO nor CO_2 alone is formed where blast is applied to hot carbon, but an intricate "complex" of CO and CO_2 depending on the temperature and pressure. If purely chemical or purely physical effects cannot even be defined to the exclusion of the other, one obviously cannot base the results of tests of one to the exclusion of the other, for practical working and pretend to have full information.

(2) The foundryman's work is not only scientific —it is an art also. However much we reduce the skill of the foundryman to applications of general rules and figures, there will still be a wide margin for the expression of the foundryman's experience and what I might call his personality. For all we know of the chemical and physical nature of pig-iron, it cannot be denied that a number of leading foundrymen, under certain conditions, use a judgment that is gained from their previous general experience, and not based solely on an array of figures, though these are used to supplement his experience.

(3) The question of cost must be considered. As is well known, the economic use of pig-iron does not depend on the least possible sum for which a given quantity of proportion of Fe, Si, Mn, etc., can be obtained; or the least possible sum the largest number of cwts. transverse; or tons tensile; can be obtained; though they are very helpful guides. It depends on the least possible sum for which the satisfactory casting can be completed.

From the point of view of a make of pig-iron, the question of providing iron to analysis presents no difficulty, but if the iron required falls outside the practical limits of consistent manufacture, the extra handling must be paid for.

The "normal limits of consistent manufacture" can be described as, say, 0.25 either way in the silicon; 0.10 above the maximum for sulphur; 0.20 either way for manganese, and 0.10 either way for phosphorus, though as one constituent affects the other the number of permutations and combinations of the quantities of the elements in pig-iron is enormous, and consequently the chances of one or other of the above elements coming outside the specification are very great. Hence the limits of "off grade" iron are vastly increased. It must be borne in mind I speak from our experience at Thorncliffe, where we maintain a most rigid chemical control of our raw materials, and I doubt whether the makers of large quantities of common iron would agree to the limits I have mentioned.

But if strict limits of the analysis are insisted upon by the buyer of pig-iron, he must not grumble if the fracture is not quite to his liking, because other factors operate, as you have explained, and no blast furnace operator can control all the factors, all the time.

Who is to Analyse?

A practical difficulty would arise in analysing. This would have to be done at the makers' works, or else the price would have to be enhanced to allow for the freight on possible rejections. As it is essential that analysis be obtained within a few hours of the cast, it would require a neutral analyst to be in residence at the blast furnaces, and this, again, would increase the cost.

Adjudication of Value.

To sum up, my personal opinion may be stated as follows regarding the quality of pig-iron I would purchase, after ascertaining precisely the type of pig-iron I required for a certain job.

Out of a hundred marks for the perfect iron in all respects, I would allot :—

50 for analysis.
15 for physical tests (under the same conditions as the finished casting).
10 for cleanness in melting.
5 for appearance of the fracture.
20 for my personal prejudice.

100

The views of foundrymen on this allotment would be of value for the various pig-iron makers of the country.

Conclusion.

The various aspects of the subject are not so simple as they appear at first to be.

If the ultimate decision should be for analysis, and analysis only, the position is a comparatively simple one, especially for the blast-furnaceman. The question of supplying to fracture only has been omitted, as this is a declining aspect, and will fade away in not many years from now.

If the ultimate decision is for fracture and analysis, then the blast-furnaceman has to meet a very large problem and solve it as best he may. No doubt it can be done, but it will involve added costs for handling and checking. It will mean for him the holding of a great many parcels of iron, each of an agreed grade of fracture and its complementary analysis. With the necessary trouble taken it can be done, but it will cost money to do it well.

A discussion followed, in which the Chairman (Mr. W. Haggas), Mr. Wood, Mr. J. Robinson, Mr. J. Haigh and others took part, and the meeting closed by votes of thanks being accorded to the lecturer, Mr. Wood, and Major Miles.

A Krupp Venture in Chile.—A cable from Valparaiso states that a representative of the Krupp concern has arrived at Santiago de Chile at the beginning of this month (March) with a view of negotiating for the erection of works by his concern.

Russian Trade Mission to Turkey.—A report from Moscow states that a delegation of the Russo-Oriental Chamber of Commerce is leaving there for Constantinople via Odessa, taking nine or ten tons of samples of Russian products and manufactures, including metal and electric goods, timber, cement, etc.

Influence of Final Rolling Temperature on Strength of Structural Steel.—Messrs. Hilding Agrell and Karl G. Dellwik, two Swedish investigators, as a result of a series of experiments carried out by them have come to the conclusion that in the case of steels with from 0.25 to 0.50 per cent. carbon content the final temperature at rolling may sink as low as 700 deg. without affecting the elastic limit, or the impact or hardness test of the steel, while if the temperature is allowed to sink below 900 deg. the extension will but slightly be affected. In the case of steels with carbon content below 0.20 per cent. and over 0.55 per cent the mechanical properties of the steel will depend on other conditions.

XUM

Physical Tests for Cast Iron.*

By John Shaw (Sheffield), M.I.Brit.F.

(*Continued from page 227.*)

Paris Conclusions.

At the International Foundrymen's Convention, held in Paris last September, there was a fairly general agreement that some modification of the present-day methods for testing cast iron was long overdue, both in the interests of the engineer and foundryman. When it is remembered that 14 nations were represented and over 1,000 delegates were present, the movement cannot be over-estimated.

M. Portevin suggested that the Fremont and Portevin methods of testing small pieces cut from the castings themselves offered a solution. While the method appears ideal, one can only say that for 14 years little or no progress has been made, the charts and figures put forward by M. Ronceray at Birmingham in 1922 being those to a great extent published by M. Fremont in 1912. However, as the American Committee are purchasing a machine, independent evidence may soon be expected.

American Conditions.

The A.F.A. adopted a standard arbitration bar in 1904. This, for several reasons, has not met with much support on the other side, and a combined Committee of the A.F.A. and the A.S.T.M. are revising the whole specification.

At a meeting of the General Council of the I.B.F., held in Coventry in 1918, it was resolved that instead of simply criticising specifications put forward by certain authorities, it would be better to embody the foundrymen's views in a tentative specification, this to be submitted to the leading engineering societies for acceptance or amendment before sending on for the approval of the B.E.S.A. This Committee of the I.B.F. started active work over two years ago. They realised from the first that if the specification was not to be a dead letter, it must carry the consent and approval of the engineers. They therefore had two objects in view. First, so to modify the size of the test-bar that it bore some relation to the section of the casting it represented, and so would have to a limited extent a similar structure. Secondly, to convince the engineer that these modifications would yield tests as high as any he had asked for before. Once this specification had been tried out by both the engineer and foundryman, a combined effort could be made to increase the test loads and help cast iron to take a better place.

This specification varies in a few vital points from the standard specifications mentioned earlier in the Paper. Clause 4, for instance, divides the castings into two grades, viz., Grade A is to include all important castings that often now call for higher tests. Grade B includes all other castings that require to conform to mechanical standards. Again, for Clause 6, the average sectional thickness of any casting shall determine the size of the test-bar to be used. Thus, for all castings where no main cross-section of the metal exceeds $\frac{3}{4}$ in. thick, a bar 0.875 in. dia. cast 15 in. long shall be used. For all castings where no main cross-section exceeds 2 in. thick, or is less than $\frac{3}{4}$ in. thick, a bar 1.2 in. dia. cast 21 in. long shall be used. For all castings where no main cross-section is less than 2 in. thick, a bar 2.2 in dia. cast 21 in. long shall be used.

Clause 7 points out that the test-pieces for Grade A shall be cast on the casting wherever possible. When practical considerations do not permit of this, or when the consent of the engineer is obtained, the procedure outlined for Grade B shall be followed. Test-pieces for Grade B may be cast separately at the option of the supplier, and shall preferably be cast in duplicate sets of two bars, each of the dimensions specified in Clause 6. The test-bars shall be made in green sand or dry sand, according as to whether the casting is made in green sand or dry sand.

The test-pieces shall be cast from the same ladle as the castings, and as nearly as possible at the same pouring temperature. The test-pieces shall possess the same thermal history as the casting it represents. (This is to provide for the growing practice of heat-treating certain work.) The test-pieces shall be tested transversely as cast, or skin machined at the option of the engineer. The transverse tests are given in Table II.

TABLE I.—*Institute of British Foundrymen draft Specification Requirements.*

Transverse		Grade A		Grade B	
Diameter of bar in inches	Distance between supports in inches	Minimum load in lbs.	Minimum deflection in inches	Minimum load in lbs.	Minimum deflection in inches
0.875	12	11.85	0.12	10.50	0.10
1.200	18	19.50	0.15	17.15	0.12
2.200	18	10.000	0.12	90.00	0.10

Tensile (Piece prepared from one portion of the transverse test)

		Grade A	Grade B
Diameter of bar in inches	Diameters after turning in ins.	Minimum maximum stress tons per sq. inch	Minimum maximum stress tons per sq. inch
0.875	0.564	12.0	10.0
1.200	0.798	11.0	9.0
2.200	1.705	10.0	9.0

Chemical Analysis.—Where physical tests are specified, the maximum percentage of P only shall be specified.

The Committee fully realised from the beginning that the test-bar only represented the quality of the metal going into the casting, and not necessarily the strength of the casting itself. They also realised that a separately cast test-bar is not an ideal method, but they felt that, in the absence of any satisfactory method of testing the casting itself, without injuring it, their first duty was to modify the present-day tests, so that they would be more satisfactory to the engineer and foundryman and lead to a better product.

Comments on Tensile Testing.

Dealing with the methods of testing, the author does not believe the tensile test is a suitable one for cast iron. This opinion is endorsed by foundrymen in most other countries. America and Germany both cut it out of their specifications. M. Portevin, in his address before the French Conference held at Nancy in 1922—an address which should be read by every foundryman and engineer—stated the four factors obtained by a complete tensile test are:—Elastic limit, ultimate tensile stress or breaking load, elongation, and reduction of area. Of these, the only two which really indicate the suitability of the material for a given purpose are the elastic limit, or the stress from which perfect recovery is possible, and the reduction of area, which is a characteristic of the ductility. Yet it is precisely the other two, that is, the breaking load and the elongation, which are frequently selected as the deciding factors. Briefly, the ordinary tensile test, owing to its long history and its apparent simplicity, has become established in an exaggerated position. As a matter of fact, the ordinary tensile test is incapable of indicating the elasticity of cast iron, for which purpose it is necessary to resort to the deflection test. It is often stated that few, if any, machines give a direct pull. The author recently examined figures relating to an interesting experiment on this point. A test-bar was cast with two 3-in. flanges about 4 in. apart cast on. The bar was machined up with the grip ends and also the

* A Paper read before the Coventry Branch, Mr. C. Dicken presiding.

faces of the flanges machined. The portion of the bar between the flanges was turned to 0.798 in. with good fillets connecting to the flanges. A gauge was fitted between the flanges, and then the bar was fixed into the tensile testing machine. Three points at an angle of 120 deg. were fixed and marked A, B and C on the edge of one flange. As soon as 2.9 tons per sq. in. was registered, it was found the gauge was very tight at A, that it would not go in at B, and that an 8/1,000 feeler went in at C. Increasing the load to 4.5 tons per sq. in., it took a 2/1,000 feeler besides the gauge at A. The gauge would not go in at B, while it took a 12/1,000 feeler to fill the gap between the gauge and flange at S. After this the load was taken off and the bar was re-measured, when the original data was obtained. The bar was again fixed in the machine, but the positions twisted 120 deg., so that the point C took B's original place, B where A was, while A took C's position. When the load was again taken up to 4.5 tons per sq. in., it was found that A (*c*) needed a 4/1,000 feeler, B (*a*) a 7/1,000 feeler, and C (*b*) a 3/1,000 feeler to fill the space. This test afforded good evidence that this particular machine did not give a straight pull. Another grave objection to the tensile test is the fact that it is more a test of the structure of the iron rather than its quality. The author emphatically states that he can obtain 11 tons per sq. in. tensile on almost any class of iron if the C.C. is round about 1 per cent., but that the corresponding deflection and transverse tests need quality as well. The hundreds of tests made by Fremont confirm this. Field unwittingly also added evidence when he stated he could obtain 15 tons per sq. in. tensile on a high-phosphorus semi-steel cast iron, but could not get the transverse with the same material.

Chemical Analysis.

Having regard to the very limited knowledge of the effect of composition, cooling effects, etc., it is not thought wise to embody complete chemical composition in any specification which calls at the same time for physical tests. The author is not aware of a single instance where a complete chemical analysis is included in a specification, where the allowable variation is not wide enough to obtain either good or bad castings at will. It stops research and suggests that the knowledge of metallurgy is complete. If this is so, why do we read such divergent views from foundrymen in the front rank? Why is it suggested in Coventry that phosphorus is detrimental between 0.4 and 0.8 per cent., while other eminent men say it is not harmful if below 1.0 per cent.? Why did Cook and Hailstone obtain an average of 15 tons tensile for sixty days using three irons, and only an average of 10 tons when a single iron was charged although the ordinary ultimate analysis was the same? Why did they obtain a net-work structure with one iron and not with the other series, although all conditions were the same as far as shop conditions will allow? Why is a cold blast iron stronger than a hot blast of the same composition? Why is good semi-steel so much finer in its graphitic carbon than an ordinary iron of the same composition? Why does Young advocate a high sulphur if the manganese is in balance for certain classes of work, while others advocate a low sulphur for the same work? Why does Smalley remelt his iron and run into chills if the iron recovers its structure fully on remelting? Why is it that an "over-grey" pig-iron that carries a No. 1 analysis has a No. 4 structure and retains it on remelting, as mentioned by Pilkinton, Houghton and others? One could continue asking these questions, showing what divergent views are held. Till our knowledge on this side is more complete, it is not wise to dogmatise about definite chemical specifications. If a further warning is needed, let them examine the following analysis, and remember that in another 20 years the statements and figures they give now with such confidence may look just as ridiculous as those below. Yet it was upon this evidence that the trained chemical staff of the Pikeville Arsenal stated that hot blast iron was inferior to cold blast.

Table III shows the corresponding figures of cold blast and hot blast pig-iron.

TABLE III.—*Relative Constitution of Cold-Blast and Hot-Blast Pig-Iron.*

	Cold Blast.	Hot Blast.
Specific gravity	7.194	7.047
Tensile strength	26,859	18,993
Com. carbon	0.0836	0.0687
Graphite	0.0476	0.0600
Silicon	0.0386	0.0593
Slag	0.0189	0.0375
Phosphorus	0.0228	0.0185
Sulphur	0.0014	0.0010
Undetermined	0.1141	0.0960
Earths	0.0117	0.0146
Silicon and carbon ...	0.1219	0.1281
Silicon and slag	0.0665	0.0975
Gr, slag and Si	0.1051	0.1568
Gr, slag, Si and P ...	0.1280	0.1753
T.C.	0.1312	0.1287
Gr, slag, P, S and earths	0.1411	0.1909

Conclusion.

The following is thought to have been established:—(1) That tests are necessary to establish the data needed to enable work to be designed; (2) that tests are needed on the actual material to prove they comply with the compiled data; (3) that one size of test bar does not give even a correct idea of the structure of the metal entering into the casting; and (4) that full chemical specifications, together with physical tests, are not satisfactory in the face of our thorough lack of knowledge on the effect of composition and mass action.

Company News.

Henry Bessemer & Company, Limited.—Loss, £22,251; adverse balance brought forward, £9,103; ditto carried forward, £31,354.

Brown Bayley's Steel Works, Limited.—2½ per cent. upon preference shares, on account of amount due for accounting period of 11 months ending July 31, 1922.

Beyer, Peacock & Company, Limited.—Loss, £73,745; depreciation, £16,440; net loss, £87,384; taken from reserve, £110,000; brought forward, £2,615; preference dividend, £16,500; carried forward, £8,731; no ordinary dividend.

Cammell, Laird & Company, Limited.—Profit, £70,053; brought forward, £29,223; instalment of 2½ per cent. on cumulative preference shares (less tax), £30,630; final dividend on preference, 6d. per share, or 2½ per cent. (less tax), £30,630; carry forward, £38,015; no dividend on ordinary.

British Aluminium Company, Limited.—Profit, including amount brought forward, £111,123; depreciation, £50,000; reserve, £60,000; staff benefit fund, £10,000; interim dividend, 5 per cent. on ordinary shares; final dividend, 10 per cent. per annum on ordinary, making 7½ per cent. for year; carried forward, £18,071.

Gibbons (Dudley), Limited.—Net profit, £19,662; brought forward, £13,946; full preference dividend; interim dividend, 7 per cent. per annum on ordinary and dividend 7 per cent. per annum on short term capital (all free of tax), £12,209; final dividend, 3 per cent. per annum, free of tax, on ordinary capital, making 10 per cent. for year; reserve, £2,500.

Moore Brothers (Birmingham), Limited, Priory Works, Priory Road, Aston, Birmingham.—Capital £30,000 in £1 shares, to adopt an agreement with the Delta Metal Company, Limited, and to acquire the business of brassfounders and manufacturers of extruded brass, bronzes or alloys, carried on by Moore Brothers, Limited. Directors: H. A. Dugard, J. W. Meyjes, E. J. Overton and A. F. H. Dick.

British Insulated and Helsby Cables, Limited.—Profit, £347,695; brought forward, £391,675; directors' and trustees' fees and remuneration to works committee, £8,998; first debenture interest, £22,500; second debenture interest, £10,000; depreciation of building plant, etc., £50,000; reserve, £50,000; first mortgage debenture stock redemption account, £5,000; final dividend, 5 per cent., together with bonus, 5 per cent., making 15 per cent. for year; carry forward, £412,873.

Scottish Iron and Steel Company, Limited.—Profit, £52,354; debenture interest, £6,373; debenture stock sinking fund, £19,876; preference dividend account, £18,000; ordinary shareholders' profits appropriation account, £8,104; interim preference dividend, 3 per cent. (less tax), final preference dividend, 3 per cent. (less tax), making 6 per cent. for year; ordinary dividend, 6 per cent. per annum (less tax); carried forward, preference shareholders, £12,900; ditto, ordinary shareholders, £9,755.

XUM

Trade Talk.

Metal Union, Limited, iron and steel merchants, have amalgamated with the firm of Paul Bass. Their address is now 66, Broad Street Avenue, London, E.C.2.

The directors of Baldwins, Limited, announce that the rumours of reconstruction to which currency has recently been given are entirely without foundation.

The Stanton Ironworks Company, Limited, near Nottingham, have just put into operation another blast furnace, making the full nine furnaces operating at Stanton.

J. C. Hill & Company, Limited, steel wire and nail manufacturers, announce that it is their intention to deal with all their correspondence from the Oakfields Steel Wire Works, Cwmbran, Mon.

Henry Bessemer & Company, Limited, have acquired the freehold of the company's Sheffield works and water rights. These were formerly held under leases expiring in about thirty years.

The Barrett Engineering Company, Limited, have commenced business at Court Street, Trowbridge, Wilts, as mechanical engineers, machinists and gear cutters. Mr. W. W. H. Barrett is managing director.

Princeps & Company, engineers, Wentworth Chambers, Pinstone Street, Sheffield, have appointed Mr. H. Graham Bell, Greenfield, Fields Park Road, Newport, Mon., as agent for their specialities in South Wales.

The tender of A. C. Potter and Company, Grantham, has been accepted by the Hull Corporation Water Committee for the pumping plant at the new works at Dunswell. The tender amounts to £38,900.

Considerable damage was recently caused by a fire at premises occupied by the Rodney Foundry Company, Limited, of Larcom Street, Walworth, London, S.E., as stores. No part of the foundry building, however, was damaged.

At Stourbridge Police Court, recently, Isaac Nash & Sons, Limited, edge-tool and vice manufacturers, were charged with failing to have dangerous machinery properly fenced on January 9. The Bench imposed a fine of 40s., and ordered the firm to pay 20s. witnesses' costs.

The Tees-side Bridge and Engineering Works, Limited, Middlesbrough, have completed 125 goods wagons for the Bombay, Baroda and Central India Railway, and have an order for 750 sets of ironwork for 12-ton end-door mineral wagons for the L.N.E.R. Other important orders are in hand.

The British Electrical and Allied Manufacturers' Association direct attention to the fact that, in furtherance of technical education, they grant annually ten scholarships, each of the value of £100, in addition to the payment of college fees. The last date for receipt of applications is June 1.

Members of the Newcastle and District Association of Foremen Engineers and Draughtsmen, to the number of about one hundred, visited, on March 15, the new gear works of George Angus & Company, Limited, St. Anthony's, Newcastle, and were received by Major Graham Angus (a director), Mr. G. F. Carrington (works manager), and Mr. C. Short. The party included Mr. Joseph Gray, president of the Society.

Hurst, Nelson & Company, Limited, railway carriage and wagon builders, of 14, Leadenhall Street, E.C.3, have removed to larger offices at 32, Great St. Helen's, Bishopsgate, E.C.3. The company's works have recently been re-organised and extended, with the result that their output of carriages, tank wagons, and steel and wood frame coal wagons has been considerably increased.

Gazette.

Mr. A. T. Pryce, lately carrying on business as a brassfounder at the Empire Works, Holliday Street, Birmingham, under the style of A. T. Pryce & Company, is paying a first and final dividend of 10s. 3d. in the £.

The partnership heretofore subsisting between Messrs. A. L. Hitchcock-Spencer and P. A. Sharman, carrying on business as engineers, boilermakers, and ironfounders, at Hitchin, under the style of W. H. Spencer & Company, has been dissolved.

Obituary.

Mr. William Holdgate, who formerly carried on business at Glossop as an iron merchant, died recently in his 80th year.

Mr. B. S. Gower, of A. W. Gower & Son, agricultural implement works, Market Drayton, died recently at the age of 82.

Mr. Harry Fisher, J.P., of Tapton Mount, Manchester Road, Sheffield, died on March 15. The deceased was born in Sheffield in 1849. He was apprenticed to the steel and file trade. Shortly after completing his period he obtained an appointment as commercial traveller for Burys & Company, Limited, steel makers, with whom he continued for close upon twenty years. In 1890 he commenced business on his own account, establishing the firm of Harry Fisher & Company, steel and file manufacturers, Kingfisher Works, Rockingham Street. There he built up a flourishing concern, which he carried on for nearly twenty years, and at the age of 60 he found himself able to retire. He introduced several improved methods of rolling and treating special classes of steel for the use of agricultural engineers. He was a director of the firm of Brown & May, Limited, agricultural implement makers, Devizes, for some sixteen years, and its chairman for about half that period.

Dr. W. H. Maw, one of the proprietors and editor of our esteemed contemporary, "Engineering," died on March 19 at his residence in Addison Road, Kensington, at the age of 85. The deceased gentleman gained his professional experience in the works of the Great Eastern Railway at Stratford. He joined the staff of "Engineering" when it was established in 1866, and shortly afterwards he acquired its copyright, in conjunction with Mr. James Dredge, another member of the staff. Subsequently Mr. A. T. Hollingsworth, a son-in-law of Sir Henry Bessemer, joined the firm and considerable success was achieved, the journal becoming one of the leading technical journals in the country. Dr. Maw also practised as a consulting engineer, and took keen interest in the affairs of several technical institutions. He was president of the Institution of Mechanical Engineers in 1901-2 and of the Institution of Civil Engineers in 1922-23, and was on the Council of the Royal Society of Arts. He assisted in the formation of the Engineering Standards Committee, was a member of the Royal Commission for the St. Louis Exhibition, and during the war served on the Advisory Panel of the Munitions Inventions Department of the Ministry of Munitions.

Personal.

Mr. Arthur Dorman, of Middlesbrough, is spending six weeks in South Africa, where he arrived on February 18.

Mr. Alexander Whitson has retired from the board of the Scottish Iron and Steel Company, Limited, and the directors have elected Mr. Wm. Downs, junr., and Mr. Matthew L. Garrett directors of the company. Both these gentlemen have held positions in the company since its incorporation.

Mr. E. J. Fox, managing director of the Stanton Ironworks Company, Limited, has been the recipient of a handsome presentation from the six executive committees representing 14,000 British working men, "as their appreciation of his efforts towards bridging the gulf between Capital and Labour."

Wills.

Douglas, W. W., of Ashlands, Bridgegate, Warmley, engineer	£55,603
Outhwaite, F., furnace manager at the Grangetown Works of Bolckow, Vaughan & Company, Limited	£4,267
Harwood, Capt. J., chairman of the engineering firm of Lang Bridge & Company, Limited, Accrington	£7,561
Meadowcroft, W., for some years partner in C. H. Meadowcroft & Brother, brassfounders and finishers, Dukinfield	£4,712
Thomas, Captain Wyndham Partridge, a director of Richard Thomas & Company, Limited	£42,231
King, D. M., of 12, Kelvinside Gardens North, Glasgow, iron founder, of David King and Sons	£20,925
Moore, T. M. J., of Sheffield, for some years chief engineer at the works of Sanderson Bros. & Newbould, Limited	£6,598

The "VULCANIA" PATENT WHEEL MOULDING MACHINE.

Patent No. 5049.

THE "VULCANIA" PATENT WHEEL MOULDING MACHINE is for moulding spur wheels with straight, sloping or Vee-shaped teeth, also bevel wheels, skew gear wheels, worm wheels and internal wheels. The machine head is carried on a pillar which is held in a base-plate bedded in the floor sand, and is made to slide on the pillar by means of a lever and link carried on a joint bearing, or by rack and pinion, or screw if thought advisable for the particular work it is being used for.

An adjustable stop collar is provided for accurately deciding the depth of mould. On the removable head a slide is carried for supporting the patterns of the teeth to be moulded. This slide is made adjustable by screw or pinion gearing to the diameter required. The number of teeth to be moulded is decided by a special dividing plate into which a steel wedge or finger engages. The special dividing plate has milled vees, at the angle of 60° inclusive, around its circumference, to receive the steel wedge, which is adjusted by a screw having an internal spring to keep it in tension and to lock the head when ramming operations are being carried out.

JAMES EVANS & CO., BRITANNIA WORKS (MANCHESTER), LIMITED.

BLACKFRIARS, MANCHESTER.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—Following the recent period of depression, it is, at all events, satisfactory to record a slight improvement in the outlook of the Cleveland iron market, the decline in values having had at last the effect of inducing more activity in buying by home consumers, who apparently realise that prices have now reached the lowest levels likely to be approached, with the result that business is in better volume than could have been anticipated. The close of the first quarter, as is customary in this market, has also brought into being a considerable demand for supplies on forward account, many consumers having run stocks to the closest limits, and with prices more favourable to buyers less hesitation is now expressed in placing orders for future deliveries. On the export side also some improvement may be noted, the recovery of the French exchange having encouraged Continental inquiry for Cleveland iron, which is now on a fairly competitive level with foreign makers, with the result that shipments from Tees-side are already about double the tonnage recorded in the corresponding period for February. In the circumstances thus outlined there are no longer rumours of further closing down of blast-furnace plants on ordinary iron in the district, but stocks in makers' yards are still heavy, and will take some time to exhaust. With regard to current prices, the standard No. 3 G.M.B. is down to 91s., with No. 1 about 94s. 6d., No. 4 foundry 90s., and No. 4 forge in the neighbourhood of 89s. per ton.

The hematite position on the East Coast remains practically unchanged, the home demand continuing irregular, although a slight improvement in Continental inquiry is reported. German makers are stated to be offering hematite to Italy at a c.i.f. price well below that of Cleveland. At this week's market values remained at the recent level, 99s. being a general quotation for East Coast mixed numbers. Some makers, however, were holding out for 99s. 6d. The No. 1 quality was at a premium of 6d. to 1s. per ton.

MANCHESTER.—Business in the local pig-iron market is still confined within the very narrow limits previously reported, the foundry industry in the district unfortunately continuing depressed and consequently restricting purchases to almost retail dimensions. The market for foundry iron is further weakened by the fact that some merchants have cheap iron on hand, which, up to the present, they had been holding for the full makers' prices, but are now offering at slightly below the makers' price for Derbyshire, now quoted 103s. delivered local. Scotch and hematite pig-iron is fairly easy here, but the latter is weaker than the former, and could be bought at about 112s. 6d. per ton.

THE MIDLANDS.—At last week's Birmingham market there was a fairly active demand for pig-iron on forward account. Derbyshire foundry iron, which had fallen in price a little, recovered, and was not obtainable under 95s., f.o.t. furnaces. Staffs. foundry iron is now firm at the same figure, and Northants. brands are in the neighbourhood of 92s. 6d. Current quotations are now as follow:—Derbyshire No. 3 foundry, 95s.; Staffordshire No. 3 foundry, 92s. 6d. to 95s.; Northants. No. 3 foundry, 92s. 6d.

SCOTLAND.—Movements in the Scottish iron trade disclose little improvement since last reported, but conditions on the whole may be regarded as steady. Consumers can hardly look for a more favourable opportunity of buying, and if they came on to the market in any degree of strength there may probably be a sharp rise in values in view of the very low production. The prices of No. 1 and No. 3 Scotch foundry are 110s. and 105s. per ton respectively, f.a.s. Glasgow. Middlesbrough iron is a shade easier again, and No. 3 is being offered in Grahamston at 97s. 6d., with No. 4 foundry 1s. per ton less.

Steel.

The position in the various branches of the steel industry has undergone little improvement since last reported, with market conditions generally inactive. As regards semi-products, imported material is still an active competitor in home markets, which will explain why the home-produced billet demand has been heavily handicapped. Acid billets, on the other hand, continue to do fairly well. There are no alterations in quotations. Open-hearth steel production is on a moderate scale, but new business is not coming forward with any freedom, while crucible steel, which recovered a little some time ago, is slipping back again. Railway and motor steel are in fairly active demand, and the electrical industry is also responsible for a considerable amount of business. In the market for alloys prices of ferro-manganese are as previously quoted, although there are [illegible] ies from abroad for a fair tonnage, but up to [illegible] present it is thought that no actual orders hav[illegible] n placed for considerable quantities.

Scrap.

In common with other departments of trade, business in all descriptions of scrap metal remains quiet, iron-founders being far from busy in all the chief centres of the industry, and in Lancashire good cast scrap, where it is sold at all, has to be disposed of at from 12s. 6d. to 15s. per ton below the price of common pig-iron, viz., at from 85s. to 90s. per ton. Special scrap from broken textile machinery may occasionally bring 92s. 6d. per ton, but this is far below its intrinsic value. In the Scottish foundry trade districts machinery cast-iron scrap is still rather stagnant at 97s. 6d., with ordinary cast iron 5s. per ton less. Foundries are still being offered, and buying cheap Continental pig-iron, which naturally causes the weakness in the demand for good cast-iron scrap. Old cast-iron railway chairs are offered at 96s. to 97s. 6d. per ton, but the demand is also poor.

Metals.

Copper.—The market for standard copper during the past week has been unfavourably influenced by the remarkable developments of the chief Continental exchanges, and with holders of the metal becoming nervous, liquidation on an extensive scale resulted in an early decline in values. Towards the end of the week the market wavered, and although the American price showed resistance at 14c. f.o.b. for electrolytic, under the better reports relating to the statistical position the trend of prices in warrant metal became rather irregular, while sentiment was to some extent affected by the slumpy conditions experienced in tin and other metals. Current quotations:—*Cash*: Thursday, £65 5s.; Friday, £66 5s.; Monday, £64 12s. 6d.; Tuesday, £65; Wednesday, £64 5s. *Three Months*: Thursday, £66 5s.; Friday, £67 5s.; Monday, £65 12s. 6d.; Tuesday, £65 17s. 6d.; Wednesday, £65 5s.

Tin.—A heavy decline in values was a noteworthy feature in the market for standard tin, fluctuations covering a wide range, due to liquidations of substantial speculative accounts, but ultimately, reassured by strong American support, recovering a steadier tendency at lower levels. The feeling as to developments in the immediate future is fairly optimistic, inasmuch as some fresh important American buying is expected to be attracted at the present level. The demand in America lately has been fairly active, and, although the arrivals there were heavy, deliveries into consumption will doubtless be maintained on a large scale. There was an increase in the home stocks, these totalling 2,891 tons, but all available tin is tightly held. Eastern smelters are in a stronger position, and the rallying movement is calculated to stimulate new trade buying. Current quotations:—*Cash*: Thursday, £273; Friday, £279 5s.; Monday, £261 5s.; Tuesday, £261 10s.; Wednesday, £254 15s. *Three Months*: Thursday, £273; Friday, £279 5s.; Monday, £261 5s.; Tuesday, £261; Wednesday, £254.

Spelter.—The market for this metal has also been affected by the conditions outlined above, but values remain comparatively firm. American quotations at the moment are closer to the London parity than for some time past, and this is tending to keep prices down. Current quotations: *Ordinary*: Thursday, £34 17s. 6d.; Friday, £35 10s.; Monday, £34 12s. 6d.; Tuesday, £34 12s. 6d.; Wednesday, £34 5s.

Lead.—The market for soft foreign pig is rather weaker, and generally values have receded from the higher levels recently reached. Current quotations:—*Soft foreign (prompt)*: Thursday, £36 5s.; Friday, £37 10s.; Monday, £35 15s.; Tuesday, £36 5s.; Wednesday, £35 10s.

FOUNDRY REQUISITES.
Try our REFRACTORIES.
Ganister or Silica Bricks and Blocks (any shape or size).
Sands, Cements, Ganister.—*Let us have your enquiries.*
THE CLEVELAND MAGNESITE & REFRACTORY CO., LTD.,
Normanby Brickworks, Normanby, Eston, Yorks.

ERITH LOAM
J. PARISH & CO.,
ERITH.